PB90-178906

Superfund Record of Decision (EPA Region 10): Commencement Bay Nearshore/Tideflats, WA. (Second Remedial Action), September 1989

(U.S.) Environmental Protection Agency, Washington, DC

30 Sep 89

U.S. Department of Commerce
National Technical Information Service
NTIS

50272-101

REPORT DOCUMENTATION PAGE

1. REPORT NO. EPA/ROD/R10-89/020

2.

3. Recipient's Accession No. PB90 178906/AS

4. Title and Subtitle
SUPERFUND RECORD OF DECISION
Commencement Bay Nearshore/Tideflats, WA
Second Remedial Action

5. Report Date 09/30/89

6.

7. Author(s)

8. Performing Organization Rept. No.

9. Performing Orgainization Name and Address

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

13. Type of Report & Period Covered 800/000

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

The Commencement Bay Nearshore/Tideflats site is in Tacoma, Pierce County, Washington at the southern end of the main basin of Puget Sound. The site encompasses an active commercial seaport and includes 10-12 square miles of shallow water, shoreline, waterways and adjacent land. Site contamination is the result of a long history of industrial activity in the area. More than 281 active industrial facilities are in the area and approximately 34 of those are NPDES permitted dischargers. Releases of hazardous substances to the marine environment have resulted in contamination of bottom sediment in the waterways of the Tideflats Industrial Area, and along the shoreline in the Nearshore Area. This Record of Decision represents two of six operable units for the site and will address source control and marine sediment contamination in the Nearshore/Tideflats environment. Eight problem areas are being addressed independently by this remedy. The remaining operable units will address remedial response to releases of hazardous substances associated with the Tacoma tar pits and the ASARCO Tacoma smelter. The primary contaminants of concern affecting the sediment are organics including PCBs and PAHs; and metals including arsenic, mercury, lead, and zinc.

The selected remedial action for this site includes an 8-year active cleanup phase for source control and sediment remediation, and a 10-year natural recovery phase. Source control remediation includes the identification and control (Continued on next page)

17. Document Analysis a. Descriptors
Record of Decision - Commencement Bay Nearshore/Tideflats, WA
Second Remedial Action
Contaminated Medium: sediment
Key Contaminants: organics (PCBs, PAHs), metals (arsenic, lead)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement

19. Security Class (This Report) None

20. Security Class (This Page) None

21. No. of Pages 251

22. Price A12

(See ANSI-Z39.18)

See Instructions on Reverse

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

PB90-178906

United States
Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R10-89/020
September 1989

EPA

Superfund Record of Decision:

Commencement Bay Nearshore/ Tideflats, WA

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
SPRINGFIELD, VA. 22161

16. Abstract (Continued)

of sources of contamination into the marine environment at the site. Sediment remediation includes a combination of natural recovery for areas expected to recover naturally within a 10-year period after source control measures are implemented, and the utilization, as appropriate, of four active sediment control alternatives to remediate approximately 1,181,000 cubic yards of contaminated sediment. The four sediment confinement options include in situ capping, (placement of clean material on top of existing substrate), confined aquatic disposal (removal of contaminated sediments with confined disposal in shallow or open-water aquatic environments using capping with clean dredged material), confined nearshore disposal (removal and confined disposal in the nearshore environment with capping and diking), and removal and upland disposal (transferring dredged material to a land-based confinement facility. In addition, the remedy will implement site use restrictions, and source and sediment monitoring. The estimated total cost for sediment remediation at the site is $32,300,000, which includes O&M costs for 10 years. Costs associated with source control activities are not included in this ROD because of the difficulty in determining what proportion of total source-related cost can be attributed directly to achieving remedial objectives.

PORTIONS OF THIS REPORT ARE NOT FULLY LEGIBLE DUE TO THE HISTORICAL NATURE OF SOME OF THE MATERIAL. HOWEVER, IT IS THE BEST REPRODUCTION AVAILABLE FROM THE COPY SENT TO NTIS.

U.S. Environmental Protection Agency
Region 10
Seattle, Washington

Commencement Bay Nearshore/Tideflats
RECORD OF DECISION

September 1989

U.S. Environmental Protection Agency
Region 10
Seattle, Washington

Commencement Bay Nearshore/Tideflats
RECORD OF DECISION

September 1989

PREFACE

This Record of Decision documents the remedial action plan for contaminated sediments and associated sources within eight discrete problem areas at the Commencement Bay Nearshore/Tideflats site. The Record of Decision serves three functions:

- It certifies that the remedy selection process was carried out in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act as amended by the Superfund Amendment and Reauthorization Act, and to the extent practicable, with the National Contingency Plan.
- It summarizes the technical parameters of the remedy, specifying the treatment, engineering, and institutional components, as well as remediation goals.
- It provides the public with a consolidated source of information about the site, the selected remedy, and the rationale behind the selection.

In addition, the Record of Decision provides the framework for transition into the next phases of the remedial process, Remedial Design and Remedial Action.

The Record of Decision consists of three basic components: a Declaration, a Decision Summary, and a Responsiveness Summary. The Declaration functions as an abstract for the key information contained in the Record of Decision and is signed by the U.S. Environmental Protection Agency Regional Administrator. The Decision Summary provides an overview of the site characteristics, the alternatives evaluated, and an analysis of those options. The Decision Summary also identifies the selected remedy and explains how the remedy fulfills statutory requirements. The Responsiveness Summary addresses public comments received on the Proposed Plan, the Feasibility Study, and other information in the administrative record.

This Record of Decision is organized into three main sections: the Declaration, the Decision Summary, and Appendices. Appendix A provides letters of concurrence from the state of Washington and the Puyallup Tribe of Indians, Appendix B consists of the Responsiveness Summary, and Appendix C presents implementation schedules for source- and sediment-related remedial activities in the eight problem areas addressed in this Record of Decision.

CONTENTS

Page

PREFACE ii

LIST OF FIGURES viii

LIST OF TABLES ix

LIST OF ACRONYMS x

DECLARATION 1

SITE NAME AND LOCATION 1

STATEMENT OF PURPOSE 1

ASSESSMENT OF THE SITE 1

DESCRIPTION OF THE REMEDY 1

DECLARATION 2

DECISION SUMMARY 4

1. OVERVIEW 4

2. SITE LOCATION AND DESCRIPTION 5

2.1 SITE LOCATION 5

2.2 CURRENT LAND USE 5

2.3 ENVIRONMENTAL SETTING 7

2.4 PROBLEM DEFINITION 7

2.4.1 Focus on Marine Environment 7
2.4.2 Relation to Other Environmental Programs and Activities 8
2.4.3 Definition of Cleanup Goals 9
2.4.4 Problem Scope 10
2.4.5 Data Needs in the Remedial Design Phase 10

3. SITE HISTORY AND ENFORCEMENT 11

3.1 SITE HISTORY 11

3.2 MAJOR SOURCE CONTROL PROGRAMS 13

3.2.1 Commencement Bay Urban Bay Action Team 16
3.2.2 TPCHD Marine Resource Protection Program 16
3.2.3 City of Tacoma 16
3.2.4 TPCHD/City of Tacoma Storm Drain Program 17
3.2.5 CERCLA Pre-remedial Program 17
3.2.6 Coordination of Source Control with Other Programs 17

Page

3.3 MAJOR SEDIMENT MANAGEMENT PROGRAMS 17

3.4 ENFORCEMENT ROLES OF EPA, ECOLOGY, AND THE PUYALLUP TRIBE 20

3.5 SCHEDULING AND COORDINATION OF SOURCE CONTROL AND SEDIMENT REMEDIAL ACTION 21

4. HIGHLIGHTS OF COMMUNITY PARTICIPATION 22

5. SCOPE OF RESPONSE ACTION WITHIN OVERALL SITE STRATEGY 24

5.1 SCOPE AND ROLE OF COMMENCEMENT BAY NEARSHORE/TIDEFLATS OPERABLE UNITS 24

- 5.1.1 Operable Unit 01 - Commencement Bay Nearshore/Tideflats Sediments 25
- 5.1.2 Operable Unit 02 - ASARCO Tacoma Smelter 25
- 5.1.3 Operable Unit 03 - Tacoma Tar Pits 26
- 5.1.4 Operable Unit 04 - ASARCO Off-Property 26
- 5.1.5 Operable Unit 05 - Commencement Bay Nearshore/Tideflats Sources 26
- 5.1.6 Operable Unit 06 - ASARCO Sediments 26

5.2 COORDINATION OF OPERABLE UNITS 05 (SOURCES) AND 01 (SEDIMENTS) 27

6. SITE CHARACTERISTICS 28

6.1 HEAD OF HYLEBOS WATERWAY 30

6.2 MOUTH OF HYLEBOS WATERWAY 32

6.3 SITCUM WATERWAY 32

6.4 ST. PAUL WATERWAY 35

6.5 MIDDLE WATERWAY 35

6.6 HEAD OF CITY WATERWAY 35

6.7 WHEELER-OSGOOD WATERWAY 37

6.8 MOUTH OF CITY WATERWAY 40

7. SUMMARY OF SITE RISKS 42

7.1 HUMAN HEALTH RISKS 42

- 7.1.1 General Strategy 42
- 7.1.2 Identification of Chemicals of Concern 43
- 7.1.3 Baseline Risk Assessment 43
- 7.1.4 Relationship to Sediment Quality Objectives 45

Page

7.2 ENVIRONMENTAL RISK ASSESSMENT 48

7.2.1 General Strategy 48
7.2.2 Identification of Problem Chemicals 49
7.2.3 Identification of Problem Areas 50
7.2.4 Relationship to Sediment Quality Objectives 51

7.3 MITIGATING FACTORS 54

7.3.1 Natural Recovery Process 58
7.3.2 Relationship to Sediment Quality Objectives 58

8. DESCRIPTION OF ALTERNATIVES 60

8.1 SEDIMENT CLEANUP OBJECTIVES AND EXTENT OF CONTAMINATION 62

8.2 KEY ELEMENTS OF CANDIDATE ALTERNATIVES 62

8.2.1 Site Use Restrictions 63
8.2.2 Source Control 63
8.2.3 Natural Recovery 66
8.2.4 Sediment Remedial Action 66
8.2.5 Monitoring 66

8.3 CANDIDATE ALTERNATIVES 67

8.3.1 Alternative 1: No-Action 67
8.3.2 Alternative 2: Institutional Controls 68
8.3.3 Alternative 3: *In Situ* Capping 68
8.3.4 Alternative 4: Removal/Confined Aquatic Disposal 68
8.3.5 Alternative 5: Removal/Nearshore Disposal 70
8.3.6 Alternative 6: Removal/Upland Disposal 70
8.3.7 Alternative 7: Removal/Solidification/Upland Disposal 73
8.3.8 Alternative 8: Removal/Incineration/Upland Disposal 73
8.3.9 Alternative 9: Removal/Solvent Extraction/Upland Disposal 75
8.3.10 Alternative 10: Removal/Land Treatment 75

8.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS 75

9. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES 86

9.1 THRESHOLD CRITERIA 86

9.1.1 Overall Protection of Human Health and the Environment 86
9.1.2 Compliance with Applicable or Relevant and Appropriate Requirements 87

9.2 PRIMARY BALANCING CRITERIA 87

9.2.1 Long-Term Effectiveness and Permanence 87
9.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment 87
9.2.3 Short-Term Effectiveness 88
9.2.4 Implementability 88
9.2.5 Cost 89

Page

9.3 MODIFYING CRITERIA 92

9.3.1 State and Tribal Acceptance 92
9.3.2 Community Acceptance 95

9.4 OVERALL RANKING 95

10. SELECTED REMEDY 97

10.1 CLEANUP OBJECTIVES 97

10.2 KEY ELEMENTS OF THE SELECTED REMEDY 98

10.2.1 Site Use Restrictions 98
10.2.2 Source Control 98
10.2.3 Natural Recovery 99
10.2.4 Sediment Remedial Action 99
10.2.5 Monitoring 103

10.3 IMPLEMENTATION 104

10.4 COSTS 106

11. STATUTORY DETERMINATION 108

11.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT 108

11.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS 109

11.2.1 Action-Specific ARARs 109
11.2.2 Chemical-Specific ARARs 110
11.2.3 Location-Specific ARARs 111
11.2.4 Other Factors To Be Considered 111

11.3 COST EFFECTIVENESS 112

11.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT/TECHNOLOGIES 112

11.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT 113

12. DOCUMENTATION OF SIGNIFICANT CHANGES 114

12.1 PROJECT SCOPE 114

12.2 SOURCE CONTROL 115

12.3 HABITAT OBJECTIVES 115

12.4 SELECTED REMEDY 115

12.5 COST ESTIMATES 117

12.6 IMPLEMENTATION SCHEDULES 117

REFERENCES 118

APPENDIX A - LETTERS OF CONCURRENCE

APPENDIX B - RESPONSIVENESS SUMMARY

APPENDIX C - IMPLEMENTATION SCHEDULES FOR SOURCE CONTROL AND SEDIMENT REMEDIAL ACTION

APPENDIX D - REVISED COST ESTIMATE FOR CONFINEMENT OPTIONS

LIST OF FIGURES

Page

Figure 1. Commencement Bay Nearshore/Tideflats study area 6

Figure 2. Commencement Bay tideflats and shoreline modifications as of 1986 12

Figure 3. Commencement Bay drainage network 29

Figure 4. Sediments at the Head of Hylebos Waterway not meeting sediment quality objectives for indicator chemicals at present and 10 years after implementing feasible source control 31

Figure 5. Sediments at the Mouth of Hylebos Waterway not meeting sediment quality objectives for indicator chemicals at present and 10 years after implementing feasible source control 33

Figure 6. Sediments in Sitcum Waterway not meeting sediment quality objectives for indicator chemicals at present and 10 years after implementing feasible source control 34

Figure 7. Sediments in Middle Waterway not meeting sediment quality objectives for indicator chemicals at present and 10 years after implementing feasible source control 36

Figure 8. Sediments at the Head of City Waterway not meeting sediment quality objectives for indicator chemicals at present and 10 years after implementing feasible source control 38

Figure 9. Sediments in Wheeler-Osgood Waterway not meeting sediment quality objectives for indicator chemicals at present and 10 years after implementing feasible source control 39

Figure 10. Sediments at the Mouth of City Waterway not meeting sediment quality objectives for indicator chemicals at present and 10 years after implementing feasible source control 41

Figure 11. Concentrations of total PCBs in English sole muscle tissue 44

Figure 12. Relationship between problem areas identified during the remedial investigation and those studied for the feasibility study 52

Figure 13. The AET approach applied to sediments tested for lead and 4-methylphenol concentrations and toxicity response during bioassays 55

Figure 14. In-waterway confined aquatic disposal of contaminated dredged material 69

Figure 15. Confined nearshore disposal of contaminated dredged material 71

Figure 16. Dredge water chemical clarification facility 72

Figure 17. Confined upland disposal and components of a typical diked upland disposal site 74

Figure 18. Key decision points and associated activities 105

LIST OF TABLES

		Page
Table 1.	Regulatory authorities for source control activities	14
Table 2.	Sites at the Commencement Bay Nearshore/Tideflats site listed in Superfund Information System	18
Table 3.	Estimated individual lifetime risks from eating fish muscle tissue containing organic compounds	46
Table 4.	Projected lifetime cancer risks for PCBs and arsenic	47
Table 5.	Sediment quality values representing the sediment cleanup objectives related to environmental risks	56
Table 6.	Major elements of the 10 candidate alternatives	61
Table 7.	Status of source control activities in Commencement Bay Nearshore/Tideflats problem areas	64
Table 8.	Major chemical-specific ARARs for remedial alternatives	77
Table 9.	Major location-specific ARARs for remedial alternatives	81
Table 10.	Major action-specific ARARs for remedial alternatives	83
Table 11.	Costs associated with candidate alternatives	90
Table 12.	Estimated costs for the four confinement options	93
Table 13.	Indicator chemicals and recovery factors	100
Table 14.	Estimated surface areas and volumes of sediments subject to sediment remedial action	101
Table 15.	Sediment remedies selected in the feasibility study and Record of Decision	[illegible]

LIST OF ACRONYMS

Acronym	Definition
AAL	Acceptable ambient level
ADI	Acceptable daily intake
AET	Apparent effects threshold
AKARTs	All known available and reasonable methods of treatment
ARAR	Applicable or relevant and appropriate requirement
CB/NT	Commencement Bay Nearshore/Tideflats
CB/STC	Commencement Bay South Tacoma Channel
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
Corps	U.S. Army Corps of Engineers
EAR	Elevation above reference
Ecology	Washington Department of Ecology
EPA	U.S. Environmental Protection Agency
HPAH	High molecular weight polycyclic aromatic hydrocarbon
LPAH	Low molecular weight polycyclic aromatic hydrocarbon
MCL	Maximum contaminant level
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
POTW	Publicly owned treatment works
PRP	Potentially responsible party
PSDDA	Puget Sound Dredged Disposal Analysis
PSWQA	Puget Sound Water Quality Authority
RCRA	Resource Conservation and Recovery Act of 1976
SARA	Superfund Amendments and Reauthorization Act of 1986
SEDCAM	Sediment Contamination Assessment Model
TBC	Other factors to be considered
TPCHD	Tacoma-Pierce County Health Department
UBAT	Urban Bay Action Team

DECLARATION

COMMENCEMENT BAY NEARSHORE/TIDEFLATS
TACOMA, PIERCE COUNTY, WASHINGTON
RECORD OF DECISION

Statutory Preference for Treatment as a Principal
Element Is Not Met and Five-Year
Site Review Is Required.

SITE NAME AND LOCATION

Commencement Bay Nearshore/Tideflats
Tacoma, Washington

STATEMENT OF PURPOSE

This decision document presents the selected remedial action for two of the six operable units of the Commencement Bay Nearshore/Tideflats (CB/NT) Superfund site in Tacoma, Washington, developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Contingency Plan (NCP). This Record of Decision is based on the administrative record for this site.

The state of Washington and the Puyallup Tribe of Indians (whose reservation is largely within or adjacent to the site) concur on the selected remedy (see Appendix A).

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this site, if not corrected by implementation of response actions selected in this Record of Decision, may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE REMEDY

The remedy selected in this Record of Decision covers two CB/NT operable units, source control (Operable Unit 05) and sediment remediation (Operable Unit 01), which were formerly referred to as a combined operable unit, *Areawide*. The function of the comprehensive remedy for these two operable units is to protect the marine environment and thereby reduce associated public health concerns.

In the *Commencement Bay Nearshore/Tideflats Feasibility Study* (Tetra Tech 1988a), which covered the former operable unit *Areawide*, nine problem areas were identified that warranted source control and sediment remediation:

Because this remedy will result in hazardous substances remaining onsite in concentrations above health-based and environmentally-based cleanup levels, a review will be conducted within 5 years after remedial action begins to assure that the remedy continues to provide adequate protection of human health and the environment. The timeframe for the 5-year review will be determined separately for source control and sediment remediation and will vary among the eight problem areas. Initiation of the 5-year review period will be scheduled by the lead management agency for each action.

30 September 1989
Date

Robie G. Russell
Regional Administrator
U.S. Environmental Protection Agency
Region 10

- Head of Hylebos Waterway
- Sitcum Waterway
- Middle Waterway
- Wheeler-Osgood Waterway
- Ruston-Pt. Defiance Shoreline.
- Mouth of Hylebos Waterway
- St. Paul Waterway
- Head of City Waterway
- Mouth of City Waterway

Response actions governed by this Record of Decision are limited to eight of the nine CB/NT problem areas listed above. As a result of new information received during public comment on the CB/NT feasibility study, the U.S. Environmental Protection Agency (EPA) has decided to reconsider the proposed plan for the Ruston-Pt. Defiance Shoreline problem area. A revised feasibility study for that problem area, now established as Operable Unit 06 (ASARCO Sediments) is currently being prepared by EPA for further public comment.

The selected remedy for the eight remaining CB/NT problem areas is defined according to cleanup objectives for both source control and sediment remediation. The remedy establishes a cleanup objective and a multi-element remedial strategy designed to achieve the objective. In general, the selected remedy will be implemented in each of the different problem areas independently of one another. The overall remedy includes a 8-year active cleanup phase for source control and sediment remediation, and a 10-year natural recovery phase.

Remedial technologies for source control, the first step in the selected remedy, include a full range of all known available and reasonable methods of treatment (AKARTs). The schedule for source control varies among problem areas but is expected to be largely accomplished during the next 8 years. The Washington Department of Ecology (Ecology) is the lead management agency for source control under a cooperative agreement with EPA.

The second step in the selected remedy, correction of sediment problems, will be accomplished through a combination of natural recovery and active sediment remediation. Areas expected to recover naturally within a 10-year period after source control measures are implemented will be monitored annually to confirm that prediction. Site use restrictions, such as advisories against seafood consumption, will be implemented to protect human health until recovery is complete. Areas not expected to recover naturally in a timely manner will be actively remediated when source control measures are designated acceptable by Ecology and EPA.

Active remediation of problem sediments will be accomplished by utilizing a limited range of four confinement technologies, each of which can provide a feasible and cost-effective means of achieving the cleanup objective for the site. These technologies are in-place capping, confined aquatic disposal, nearshore disposal, and upland disposal. The selected remedy provides performance objectives for each of these confinement technologies and allows the flexibility to implement any or all of them during the active cleanup phase of the project. EPA will be the lead agency for implementing sediment remediation. The Puyallup Tribe of Indians has been established as a supporting agency for the project through a cooperative agreement with EPA.

DECLARATION

The selected remedy is protective of the marine environment and related human health concerns. The remedy also complies with federal, state, and tribal requirements that are applicable or relevant and appropriate for this remedial action, and it is cost-effective. This remedy uses permanent solutions and alternative treatment technologies to the maximum extent practicable for this site. The feasibility of permanent treatment will be evaluated on a case-by-case basis by Ecology for the purposes of source control. However, treatment of contaminated marine sediments was not judged practicable at this site because CB/NT problem sediments are characterized by relatively low concentrations of contaminants and relatively large volumes of material. Therefore, this remedy does not satisfy the statutory preference for treatment as a principal element of the remedy.

DECISION SUMMARY

1. OVERVIEW

The Decision Summary provides a condensed description of the site-specific factors and analysis that led to selection of the remedy for the Commencement Bay Nearshore/Tideflats (CB/NT) Superfund site, beginning with the early identification and characterization of the problem (documented in the remedial investigation), proceeding through the identification and evaluation of candidate remedial alternatives (documented in the feasibility study), and concluding with the remedy selected in this Record of Decision. The involvement of the public throughout the process is also described, along with the environmental programs and regulations that relate to or direct the overall site remedy. The way in which the selected remedy meets CERCLA requirements is also carefully documented.

The Decision Summary is provided in the following sections. Section 2 describes general characteristics of the site. Section 3 provides site history and discusses the coordination of enforcement activities. Community participation is highlighted in Section 4. The scope of the response actions is described in the context of the overall site strategy in Section 5. Site characteristics and a summary of site risks are provided in Sections 6 and 7, respectively. Candidate alternatives are described and compared in Sections 8 and 9, respectively, and the selected remedy is presented in Section 10. The conformance of the selected remedy with statutory requirements is described in Section 11, and significant changes between the remedy described in the proposed plan and the remedy selected in the Record of Decision are described in Section 12.

2. SITE LOCATION AND DESCRIPTION

2.1 SITE LOCATION

The CB/NT Superfund site is located in Tacoma, Washington at the southern end of the main basin of Puget Sound (Figure 1). The site encompasses an active commercial seaport and includes 10-12 square miles of shallow water, shoreline, and adjacent land, most of which is highly developed and industrialized. The upland boundaries of the site are defined according to the contours of localized drainage basins that flow into the marine waters. The marine boundary of the site is limited to the shoreline, intertidal areas, bottom sediments, and water of depths less than 60 feet below mean lower low water. The nearshore portion of the site is defined as the area along the Ruston shoreline from the mouth of City Waterway to Pt. Defiance. The tideflats portion of the site includes the Hylebos, Blair, Sitcum, Milwaukee, St. Paul, Middle, Wheeler-Osgood, and City waterways; the Puyallup River upstream to the Interstate-5 bridge; and the adjacent land areas. Because the landward boundary of the CB/NT site is defined by drainage pathways rather than political boundaries, the precise landward extent of the site may be adjusted as new information regarding surface water and groundwater flow patterns is developed.

2.2 CURRENT LAND USE

The CB/NT site is located within the city of Tacoma, which has a population of 162,100. The land, water, and shoreline within the study area are owned by various parties, including the state of Washington, the Port of Tacoma, the city of Tacoma, Pierce County, the Puyallup Tribe of Indians, and numerous private entities. Much of the publicly owned land is leased to private enterprises. Within the site boundaries, land use is chiefly industrial and commercial.

The Port of Tacoma owns approximately 35-40 percent of the 2,700 acres that make up the port and industrial areas within the CB/NT site. The port operates many cargo handling and storage facilities along the waterways and leases other properties to large and small industrial, manufacturing, and commercial tenants. Many of the remaining properties within the port and industrial area were under port ownership at one time, but have since been sold. Major private landowners include lumber, chemical, and petroleum companies. Property along the Hylebos Waterway is owned almost exclusively by private companies, and there are several privately-owned parcels along the Blair Waterway. Other privately owned parcels are found predominantly at the landward end of the port and industrial area.

A large portion of the tideland and offshore areas of the CB/NT site is either owned outright by the state or is designated as state-owned harbor areas. The Port of Tacoma owns tidelands and bottom sediments in several areas including the head of Hylebos Waterway, the head of Blair Waterway, and Milwaukee and Sitcum waterways. The St. Paul and Wheeler-Osgood waterways are privately owned. Private ownership of shorelines and intertidal areas in many portions of the site generally corresponds with ownership of the adjacent upland property parcels.

The Puyallup Tribe of Indians has asserted title to land in the Tacoma tideflats area, including former Puyallup River bottomland and filled tidelands adjacent to the Puyallup Reservation. Negotiations among the Puyallup Tribe of Indians, the federal government, the state of Washington, the Port of Tacoma, and other affected parties were completed during the summer of 1988 to resolve various land ownership issues. The settlement agreement was approved on 27 August 1988 by tribal members and by federal, state, and local governments. On 21 June 1989, the Puyallup Tribe of Indians Settlement Act of 1989 was signed into law by the President, incorporating the August 1988 settlement agreement and technical documents. Efforts are underway to implement the terms of the agreement, which adds to the tribe's land base and provides for substantial restoration and enhancement of fisheries resources. Several large parcels of property within the

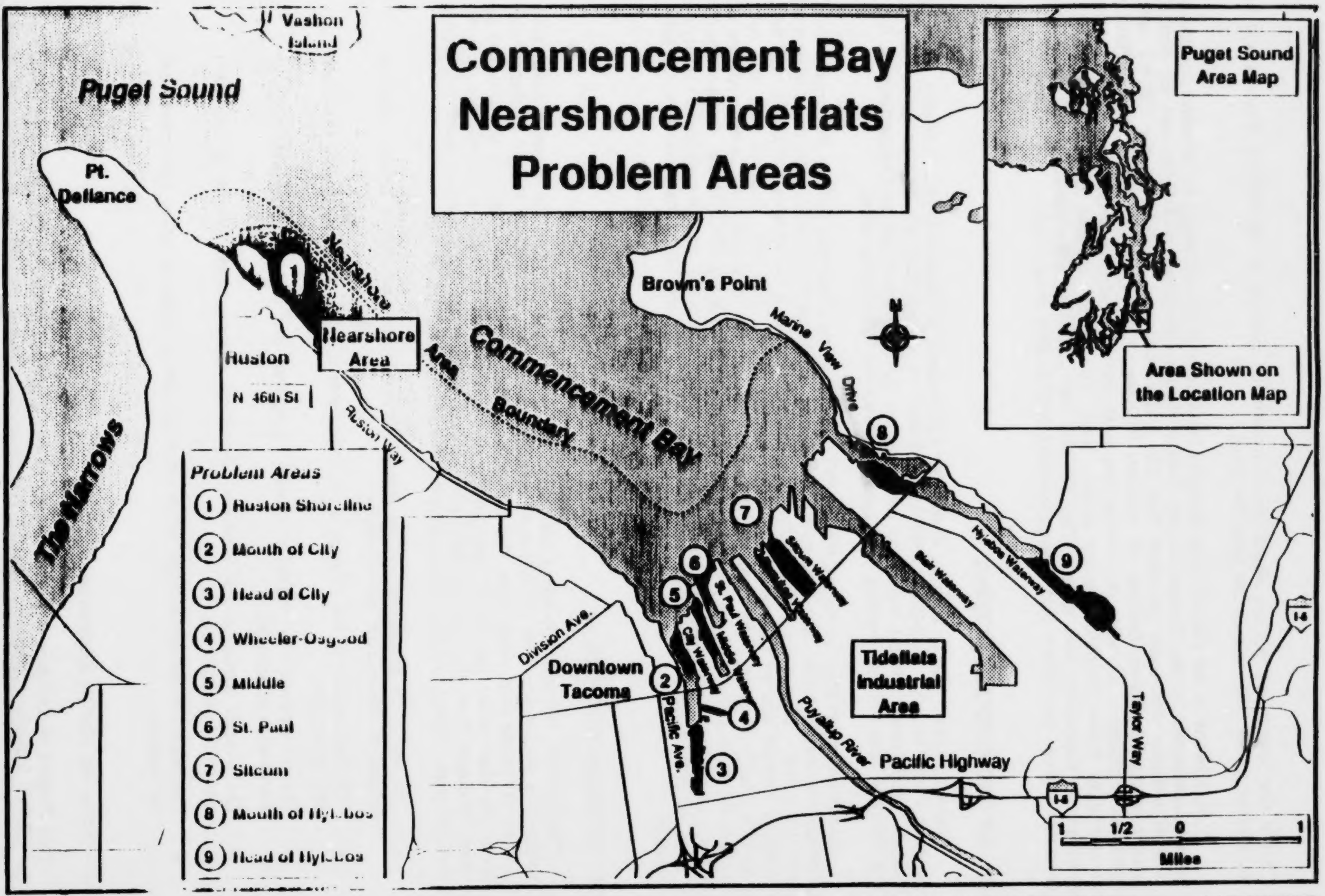

Commencement Bay
Nearshore/Tideflats
Problem Areas
Puget Sound Area Map
Area Shown on the Location Map
Vashon Island
Puget Sound
Pt. Defiance
The Narrows
Ruston
N 46th St
Ruston Way
Nearshore Area
Nearshore Area Boundary
Commencement Bay
Brown's Point
Marine View Drive
N
Downtown Tacoma
Division Ave.
Pacific Ave.
City Waterway
Middle Waterway
St. Paul Waterway
Sitcum Waterway
Blair Waterway
Hylebos Waterway
Tideflats Industrial Area
Puyallup River
Pacific Highway
Taylor Way
I-5
1
1/2
0
1
Miles
Problem Areas
1 Ruston Shoreline
2 Mouth of City
3 Head of City
4 Wheeler-Osgood
5 Middle
6 St. Paul
7 Sitcum
8 Mouth of Hylebos
9 Head of Hylebos
1
2
3
4
5
6
7
8
9

Figure 1. Commencement Bay Nearshore/Tideflats study area

CB/NT site boundaries that are slated for environmental cleanup by the Port of Tacoma will be transferred to the tribe within the next few years.

Contaminants in the CB/NT area originate from both point and nonpoint sources. Industrial surveys conducted by the Tacoma-Pierce County Health Department (TPCHD) and the Port of Tacoma indicate that there are more than 281 active industrial facilities in the CB/NT area. Approximately 34 of these facilities are National Pollutant Discharge Elimination System (NPDES)-permitted dischargers, including two sewage treatment plants. Nonpoint sources include two creeks; the Puyallup River; numerous storm drains, seeps, and open channels; groundwater seepage; atmospheric deposition; and spills. The TPCHD has identified approximately 480 point and nonpoint sources that empty into Commencement Bay (Rogers et al. 1983).

2.3 ENVIRONMENTAL SETTING

Commencement Bay is a large, deepwater embayment of approximately 9 square miles in southern Puget Sound. In March 1987 Puget Sound was designated by EPA as an estuary of national significance. Several waterways including the Puyallup River adjoin Commencement Bay. The drainage area for the Puyallup River is approximately 950 square miles.

Commencement Bay, including the CB/NT site, supports important fishery resources. Four salmonid species (chinook, coho, chum, and pink) and steelhead trout occupy the bay for part of their life cycle. Recreational and commercial harvesting of these species occurs in the bay. Extensive inshore marine fish resources include English sole, rock sole, flathead sole, c-o sole, sand sole, starry flounder, and speckled sand dab. Rock sole, c-o sole, and several species of rockfish are most abundant along the outer shoreline. Although the TPCHD has warned against regularly consuming fish, shellfish, and crabs caught within the study area, recreational harvesting of many of these species occurs, primarily within City Waterway and along the Ruston-Pt. Defiance Shoreline.

2.4 PROBLEM DEFINITION

The CB/NT remedial investigation/feasibility study and selection of remedy have been conducted in accordance with CERCLA as amended by SARA, commonly known as Superfund. However, given the large study area, the multiplicity of contaminant sources, and the diversity of ongoing activities within the CB/NT site, project development and selection of remedy has differed in many respects from the reports and implementation strategies developed at more traditional Superfund sites. There are five key aspects of this project that are unique:

- The focus on protection of the marine environment and public health concerns related to the marine environment
- The relationship of the project with other federal, state, tribal, and local programs and authorities
- The development of sediment quality objectives that address a diverse range of chemical contaminants
- The overall scope of the problem, including a very large volume of sediment requiring remediation
- The need for additional data in the remedial design phase to refine and implement the remedy.

2.4.1 Focus on Marine Environment

This Record of Decision is intended only to guide actions related to the goals and objectives of the CB/NT Superfund project. The CB/NT Superfund project focuses on contaminated marine sediments, contaminant sources, impacts to marine organisms, and related human exposure pathways. Therefore, although the CB/NT site includes a large and active urban embayment, response actions governed by this Record of Decision are designed to address specific problems associated either with the marine environment or with public health concerns related to the marine environment. The CB/NT Superfund project is not intended to address other types of environmental or public health problems within the site boundaries that should be adequately covered by other federal, state, tribal, or local programs. Problems not within the scope of the CB/NT project include contaminated properties and sources of contamination within the site boundaries that have not been determined to impact marine sediments.

CB/NT response actions are further focused by this Record of Decision to address specific problem areas within the overall site boundaries. As described in Section 3.4, the identification of potentially responsible parties (PRPs) by EPA will also focus on owners and operators of businesses and properties associated with contaminated sediments within the eight specific problem areas addressed by this Record of Decision.

2.4.2 Relation to Other Environmental Programs and Activities

Numerous local, state, and regional programs developed during the course of the CB/NT project are similarly focused on the protection of marine resources and management of marine sediments, as described in the next section. The attainment of CB/NT cleanup objectives under the Superfund program will require effective coordination with these and other environmental and public health programs. Jurisdictional considerations will be important during project implementation in order to differentiate Superfund-related activities from activities regulated according to other programs and authorities.

Correction of sediment contamination problems throughout the CB/NT site will be accomplished through a combination of activities implemented under both Superfund and non-Superfund authorities, including:

- Site use restrictions (e.g., public warnings and fisheries advisories to reduce potential human exposure) implemented by state and local health authorities
- Source control measures to reduce or eliminate ongoing releases of hazardous substances implemented through the following authorities:
    - Wastewater discharges regulated under state and federal water quality laws
    - Stormwater and industrial pretreatment requirements implemented under federal, state, and local laws and regulations
    - Ecology's Commencement Bay Urban Bay Action Team (UBAT) oversight and enforcement of source control measures
- Natural recovery through chemical degradation, deposition of clean sediments, and diffusive loss of contaminants to overlying water
- Sediment remedial actions for more significantly contaminated sediments using appropriate confinement technologies (e.g., removal, capping, disposal) conducted under the federal Superfund law.

The effective integration of the key project elements, related activities, and environmental authorities described above will be critical in the ultimate attainment of CB/NT cleanup objectives.

2.4.3 Definition of Cleanup Goals

The CB/NT project was further complicated by the lack of promulgated sediment standards to serve as project cleanup objectives. Because of the focus on the marine environment, the development of cleanup objectives for the project had a similar emphasis on environmental risk assessment methods. As described in Section 7.2, these methods utilize a preponderance-of-evidence approach that is based on a suite of three biological indicators. The cleanup objectives are further adjusted to be protective of related human health concerns (see Section 7.1). In both cases, cleanup levels have been established in relation to reference area conditions. Management of site risks was based on the assumption that it would be infeasible to establish sediment cleanup objectives for the CB/NT site that were cleaner than reference areas.

Initially, the attempt to develop definitive cleanup objectives for the CB/NT site was complicated by the almost complete lack of definitive standards, guidelines, or criteria for defining acceptable levels of contaminants in marine sediments. However, the *1989 Puget Sound Water Quality Management Plan* (PSWQA 1988) specified numerous goals and policies applicable to the CB/NT area. For purposes of defining sediment cleanup goals and requirements, two program elements of the PSWQA plan are of particular importance: standards for classifying sediments having adverse effects (Element P-2) and guidelines for sediment cleanup decisions (Element S-7).

Element P-2 requires Ecology to develop and adopt regulatory standards for identifying and designating sediments that have observable acute or chronic adverse effects on biological resources or pose a significant health risk to humans. The standards for defining "sediments that have acute or chronic adverse effects" may incorporate chemical, physical, or biological tests and must clearly define interpretive guidelines. Initial standards may exclusively address biological effects, but shall be revised to include human health concerns as pertinent information becomes available. The standards are to be used to assess discharges through NPDES (Element P-7), stormwater (Element SW-4), and nonpoint programs; to identify sites with sediment contamination (Element S-8); and to limit the disposal of dredged material (Element S-4).

Element S-7 requires Ecology to develop guidelines for determining when to implement sediment remedial action. The guidelines will consider regulatory deadlines for making decisions, natural recovery periods for sediments, procedures for determining priorities for action (including consideration of costs), and trigger levels for defining sediments that require expedited remedial action. Sediment remedial action trigger levels may be higher than the standards developed under Element P-2.

The sediment quality goal of Element P-2 was adopted as the long-term sediment quality goal for the CB/NT site. As in other parts of Puget Sound, this sediment quality goal is meant to establish levels of sediment contamination that would be acceptable throughout the CB/NT area. It is a long-term goal to be achieved through numerous actions over a period of years. The factors associated with translating this goal into project cleanup objectives will vary depending on the type of action needed, statutory requirements, and site-specific considerations.

In accordance with the focus of the CB/NT project and the goals of the 1989 PSWQA plan, cleanup objectives were developed for the project according to the following parameters:

- **Sediment Quality Goal:** The sediment quality goal is a conceptual target condition for Puget Sound, defined by Element P-2 of the 1989 PSWQA plan as the absence of acute or chronic adverse effects on biological resources or significant human health risk.
- **Sediment Quality Objective:** The sediment quality objective is a discrete and measurable target for project cleanup related to the Puget Sound goal. The objective is measurable in terms of specific human health risk assessments and environmental effects tests, and associated interpretive guidelines. The resulting biological effect levels or chemical concentrations are scientifically acceptable definitions of the sediment quality goal using available information.
- **Sediment Remedial Action Level:** The sediment remedial action level differentiates areas that exceed the sediment quality objective, but are predicted to recover naturally, from those that are more significantly contaminated and therefore require active remediation to achieve the sediment quality objective. The intent of any

active remediation of sediments is to achieve a net environmental and public health benefit and therefore requires consideration of habitat issues.

- **Source Control Level:** The goals and objectives of source control are defined as targets that will achieve respective sediment goals and objectives. Source control will be implemented according to applicable or relevant and appropriate requirements (ARARs) and AKARTs. Compliance with the sediment quality objective will be confirmed through monitoring.

2.4.4 Problem Scope

The development of a comprehensive remedy for CB/NT site is complicated by various site characteristics. The broad geographic area includes various sources, contaminants, and associated biological effects and human health risks. Remediation of sediment contamination is inherently complex because 1) the concentration of habitat and food sources at the sediment-water interface create conditions that are sensitive to contaminant accumulation, 2) contaminants that accumulate in sediments are generally dispersed from their sources, resulting in relatively large areas of low-level contamination, 3) surface sediment contamination reflects both historical and on-going contamination because sediment accumulation is a relatively slow process (e.g., CB/NT sediments typically accumulate at rates from 0.2 cm/yr to 2 cm/yr) and sediment reworking and benthic activity mix sediment over the upper 5-15 cm, and 4) the relatively large volumes of sediments requiring remediation present considerable problems regarding disposal site availability and capacity.

To effectively deal with the broad geographic area and multiplicity of sources, high priority problem areas were identified and treated independently of one another. Source control and cleanup are being implemented on an individual basis, but subsequent sediment remediation will be conducted as a concerted effort in each problem area by multiple and diverse PRPs. The remedies developed for individual problem areas also require that various types of activities (i.e., use restrictions, source control, remedial action and natural recovery, and monitoring) be implemented in an integrated fashion.

2.4.5 Data Needs in the Remedial Design Phase

The data collection efforts in the remedial investigation/feasibility study were designed to characterize contamination problems, identify priority areas requiring remediation, and evaluate remedial alternatives. The data analyzed in the remedial investigation/feasibility study were not adequate to fully determine the effectiveness of source controls previously implemented or to fully define the volume of sediment exceeding the cleanup objective. Therefore, information developed during sediment remedial design and future source monitoring plays a key role in the refinement of the selected remedy for many problem areas. Details of the timing and purpose of major phases of source and sediment monitoring are provided in Section [illegible].0. Furthermore, several source control actions have been implemented since the source loading analysis was conducted. Data gaps associated with sources will be addressed under the source control programs directed by Ecology. While source control programs address many aspects of source-related contamination, actions that diminish impacts on sediment are the central focus of the CB/NT Superfund project. Consequently, source loading data (i.e., on the amount of each contaminant discharged to each of the problem areas) provide the most important information for determining the effectiveness of source controls, the relative contributions of problem chemicals by ongoing sources, and the need for additional source controls.

3. SITE HISTORY AND ENFORCEMENT

This section presents a synopsis of the history of industrial development and CERCLA actions at the CB/NT site, and provides an overview of CERCLA and non-CERCLA enforcement tools available for implementing remedial actions.

3.1 SITE HISTORY

At the time of urban and industrial development in the late 1800s, the south end of Commencement Bay was composed largely of tideflats formed by the Puyallup River delta. Dredge and fill activities have significantly altered the estuarine nature of the bay since the 1920s. Intertidal areas were covered and meandering streams and rivers were channelized (Figure 2). Numerous industrial and commercial operations have located in the filled areas of the bay, including shipbuilding, chemical manufacturing, ore smelting, oil refining, food preserving, and transportation facilities.

With industrialization, the release of hazardous substances and waste materials into the environment has resulted in alterations to the chemical quality of waters and sediments in many areas of the bay. Contaminants found in the area include arsenic, lead, zinc, cadmium, copper, mercury, and various organic compounds such as polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs).

Commencement Bay was placed on a national interim list of 115 highest priority hazardous waste sites on 23 October 1981. Initially, the Commencement Bay site was divided into four areas: deepwater, nearshore, tideflats/industrial, and south Tacoma channel. The National Priorities List promulgated on 8 September 1983 designated the CB/NT area and the Commencement Bay South Tacoma Channel (CB/STC) as separate National Priorities List sites. The deepwater portion of the bay was eliminated from the list at that time because water quality studies indicated there was minimal contamination in the area.

On 13 April 1983, EPA announced that a cooperative agreement had been reached with Ecology to conduct a remedial investigation/feasibility study on the nature and extent of contamination in the CB/NT site. Under the agreement, Ecology was designated as the lead agency for the investigation. The *Commencement Bay Nearshore/Tideflats Remedial Investigation* (Tetra Tech 1985), completed in August 1985, characterized the nature and extent of contamination at the site. The *Commencement Bay Nearshore/Tideflats Feasibility Study* (Tetra Tech 1988a) was completed in December 1988, described feasible alternatives for sediment remedial action at the site. The feasibility study included an integrated action plan (PTI 1988) to coordinate ongoing source control efforts and sediment remedial alternatives, and a sediment quality goals document (PTI 1989) to develop sediment quality objectives. Public comment on the feasibility study was received from 24 February to 24 June 1989. General notice letters were sent by EPA to 133 PRPs on 24 April 1989 informing them of their potential liability for sediment contamination at the CB/NT site.

Contaminated sediments along the Ruston-Pt. Defiance Shoreline were further characterized during a site-specific remedial investigation for the ASARCO Tacoma smelter which was presented as public comment on the CB/NT feasibility study and proposed plan. These investigations confirmed a direct link between the ASARCO facility and sediment contamination. Due to these findings, sediment remedial action for the Ruston-Pt. Defiance Shoreline will not be addressed under the CB/NT sediments Record of Decision. Following public comment on a revised study and proposed plan, they will be addressed under a separate Record of Decision for a newly defined operable unit for the ASARCO sediments (see Section 5.1).

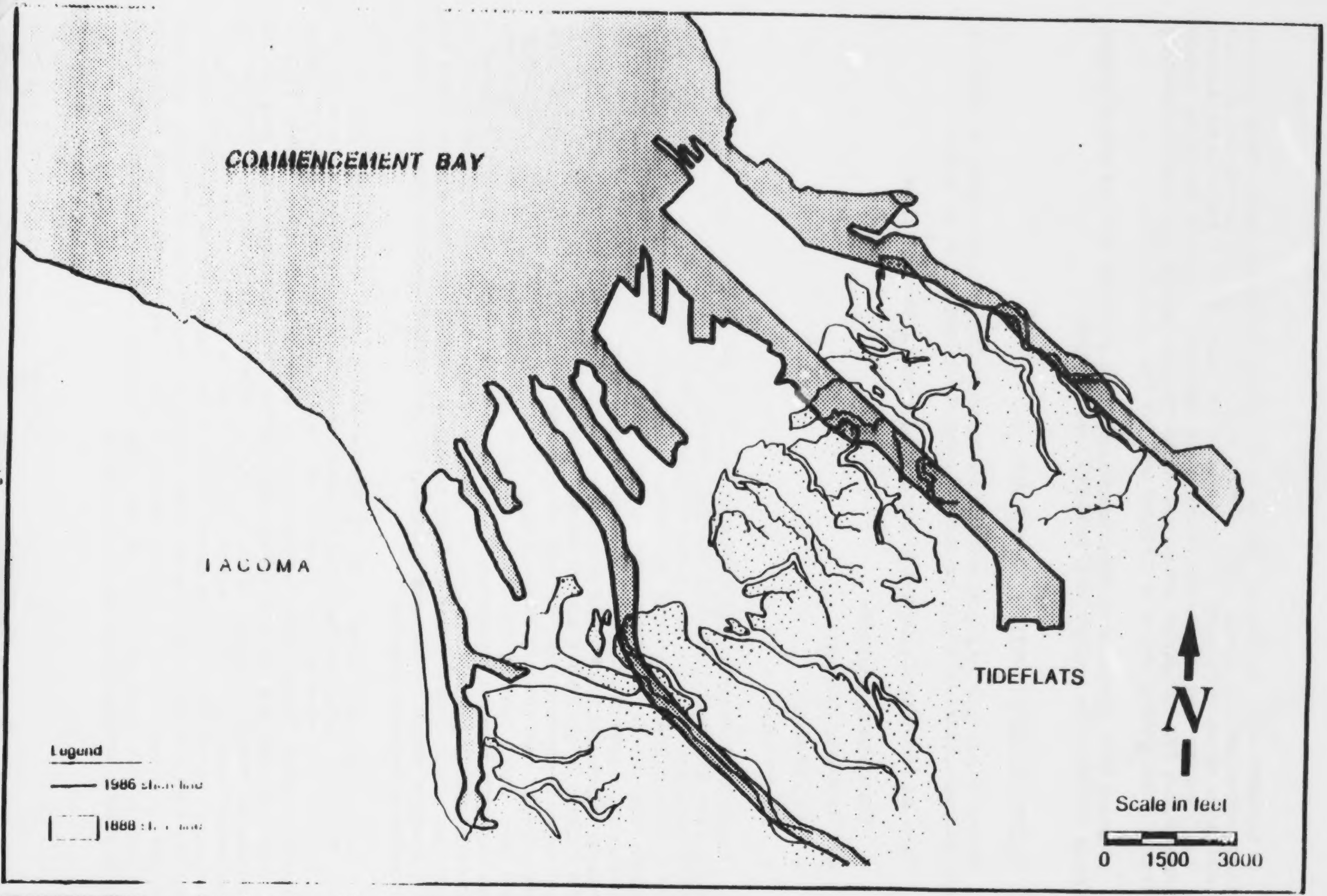

COMMENCEMENT BAY
TACOMA
TIDEFLATS
N
Scale in feet
0 1500 3000
Legend
1986 shore line
1888 shore line

Figure 2 Commencement Bay tideflats and shoreline modifications as of 1986

In September 1988, the Simpson Tacoma Kraft Company completed source control activities and implemented sediment cleanup action. These actions, which were undertaken as part of a state consent decree signed in December 1987, consisted of the placement of a layer of clean sediment (i.e., a sediment cap) over contaminated sediments and restoration of intertidal and shallow subtidal habitats. Future EPA enforcement actions will expand response activities (e.g., sediment monitoring activities) at this problem area to be consistent with this Record of Decision.

In several areas, additional sediment sampling has been conducted either as part of planned dredging activities or in anticipation of pending CERCLA action.

3.2 MAJOR SOURCE CONTROL PROGRAMS

Several federal, state, and local programs address source control independently of CERCLA. These programs and the CERCLA pre-remedial program are described in this section.

There are four general categories of contaminant sources at the CB/NT site:

- Contaminated properties
- Wastewater discharges
- Air emissions
- Storm drains.

Contaminated properties exist throughout the CB/NT site. In many cases, groundwater and surface water discharges from these facilities represent significant sources of contamination to CB/NT sediments. In other cases, active facilities discharge wastewater to Commencement Bay directly via outfalls or storm drains. Wastewater discharged from some of these facilities contains problem chemicals that may contaminate receiving waters and sediments. Wastewater discharges are subject to regulation under one of three discharge programs: 1) NPDES, 2) Washington waste discharge permit, and 3) industrial pretreatment program. Historical and ongoing air emissions from facilities in the CB/NT site are sources of contamination via the deposition of airborne particulates. Stormwater runoff has been identified as a major source of heavy metals and other chemicals [e.g., high molecular weight polycyclic aromatic hydrocarbons (HPAHs) in Commencement Bay]. Only a small fraction of over 400 storm drains that discharge to the bay have been associated with sediment contamination. Control of storm drains and stormwater runoff is addressed under the federal Clean Water Act, the 1989 PSWQA plan (PSWQA 1988), and state water quality law. Under these programs, EPA and Ecology are required to develop a permit system and issue discharge permits for storm drains, and city and county governments are required to develop stormwater management programs.

Source control enforcement at the CB/NT site invokes many environmental programs and laws. Regulatory authorities and programs under the Resource Conservation and Recovery Act (RCRA), the Clean Water Act, the Clean Air Act, the Hazardous Waste Management Act, and the Washington Model Toxics Control Act are critical for enforcing source control actions (Table [illegible]). In addition to these laws, the 1989 PSWQA plan (PSWQA 1988) establishes various programs and requirements related to source control (as well as sediment contamination). Programs and requirements under the PSWQA plan are designed primarily for enforcement and promulgation by Ecology. Enforcement of source control actions is accomplished primarily by the Commencement Bay UBAT, a task force organized under Ecology's Urban Bay Action Program, and other programs of Ecology, the city of Tacoma, and the TPCHD. These programs operate independently of CERCLA, both within the CB/NT site and offsite. However, CERCLA-directed source control will be closely coordinated with the above programs.

TABLE 1. REGULATORY AUTHORITIES FOR SOURCE CONTROL ACTIVITIES

Authority	Activities
Contaminated Facilities	
Federal and state hazardous substance cleanup programs under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Model Toxics Control Act	Under federal and state authorities, investigations, assessments, and remediation (including remedial investigation/feasibility study) are required by EPA and Ecology.
State Dangerous Waste Regulations	Procedures and criteria for identifying dangerous waste and extremely hazardous waste are enforced by Ecology.
Federal Resource Conservation and Recovery Act (RCRA)	Under federal authority, EPA and Ecology impose a permit system for facilities that treat, store, or dispose of hazardous materials.
Tacoma Pierce County Health Department (TPCHD) Solid Waste Permit	Under authority of state solid waste laws and regulations, TPCHD issues permits for disposal sites for nonhazardous solid waste in the Tacoma area.
Wastewater Discharges	
National Pollutant Discharge Elimination System (NPDES)	Under the federal Clean Water Act, NPDES permits are required for all facilities with direct discharges to surface waters (NPDES permits will subsequently be required for some stormwater discharges).
Washington State Waste Discharge Permits	Washington state requires that all known available and reasonable methods of treatment be utilized for discharges of wastewater to surface water, municipal treatment plants, and groundwater (does not duplicate NPDES).
Industrial Pretreatment Program	Under the federal Clean Water Act, EPA set effluent standards for certain industry categories for discharges to municipal treatment plants. The city of Tacoma operates an industrial pretreatment program and issues permits to industries discharging to the treatment plant (program does not duplicate state waste discharge permits).

TABLE 1. (Continued)

Authority	Activities
Air Emissions	
Puget Sound Air Pollution Control Agency and Ecology	Prevention of Significant Deterioration permits are issued by either the Puget Sound Air Pollution Control Agency or Ecology, depending on source type. Ecology's air section issues permits for the aluminum, pulp and paper, and refinery industries. (Notice of Construction permits are issued by the Puget Sound Air Pollution Control Agency for facilities under construction.)
Storm Drains	
NPDES	The NPDES program has established a schedule for permitting storm drain systems based on the size of the service area. Permits will require development of plans for contaminant control.
TPCHD and city of Tacoma Marine Resource Protection Program and Storm Drain Program	These programs include source mapping, storm drain sampling, source control, interagency coordination, nonpoint source investigations, and permit reviews.
City of Tacoma storm drain construction and maintenance	Sewer inspections are conducted to assess physical integrity and proper function, and verify sewer hookups and sanitary sewer/stormwater separation.

3.2.1 Commencement Bay Urban Bay Action Team

Based on the results of the CB/NT remedial investigation, the Commencement Bay UBAT was formed by Ecology to expand previous and ongoing source control activities at the CB/NT site. Prior to 1987, the action team relied on state water quality and dangerous waste legislation (e.g., RCW 90.48 and 70.105) to enforce source control and remedial activities related to sources. Unilateral administrative orders as well as consent orders and decrees are the primary enforcement tools under these laws. After 1987, consent orders and decrees were issued pursuant to the enforcement authority set forth in the state Hazardous Waste Cleanup Act (RCW 70.105B). RCW 70.105B was replaced by the Model Toxics Control Act in March 1989, and all consent orders and decrees were subsequently issued from the enforcement provisions of the new law. The Model Toxics Control Act provides for direct intervention and cleanup of hazardous substances by the state and includes a provision for recovery of treble damages.

Discharge permits are also used to enforce source control activities at the CB/NT site. Discharge permits, provided for by NPDES under the Clean Water Act, are written and enforced by three programs at Ecology: the Commencement Bay UBAT, the southwest regional office water quality program, and the industrial section. NPDES permits are used to regulate direct surface water discharges. However, the effluent limits set in the permits have rarely included limits for toxic contaminants. The 1987 Clean Water Act and Element P-6 of the PSWQA plan (PSWQA 1988) both require adding toxic contaminant limits to NPDES permits. In addition to direct discharges, NPDES permits cover diffuse discharges such as sandblasting waste from shipyards and ship repair facilities.

Under the 1987 Clean Water Act, NPDES permits will be required for industrial storm drains and for cities with storm drains serving total populations of more than 250,000 by February 1991. NPDES permits will be issued to smaller cities serving populations of 100,000-250,000 by February 1993. In addition, the PSWQA plan requires that local governments begin developing stormwater management programs by 1 July 1989, and demonstrate significant progress by 1 July 1991. By the year 2000, the programs must be implemented.

The Commencement Bay UBAT coordinates its efforts with several other Ecology programs in enforcing source control activities. The solid and hazardous waste program and the hazardous waste investigations and cleanup program control dangerous or hazardous wastes that have been handled, stored, treated, or disposed of at the CB/NT site. The industrial section of Ecology administers NPDES permits; regulates solid and hazardous waste; and oversees cleanup of soil, air, and water for the aluminum, pulp and paper, and petroleum industries at the CB/NT site.

3.2.2 TPCHD Marine Resource Protection Program

The marine resource protection program was initiated by the Tacoma city council in April 1985 to improve water quality in Commencement Bay. Marine resource protection activities include mapping of pollution sources and new outfalls, routine storm drain sampling, source control, interagency coordination, investigation of nonpoint pollution, monitoring of Tacoma's industrial pretreatment program, and review of NPDES permits (Pierce et al. 1987). When contamination problems are discovered, marine resource protection personnel work with the source facility owner or operator, Ecology, city of Tacoma, and TPCHD to implement best management practices or other measures to minimize or eliminate contaminant discharges.

3.2.3 City of Tacoma

In 1984, under authority of Clean Water Act Section 307, the city of Tacoma established an industrial pretreatment program. Under the program, EPA sets effluent standards for certain categories of industries. Industries that discharge effluent to sanitary sewers must meet these standards. Stricter standards may be set by the municipal wastewater treatment plant receiving the effluent, to meet the permitted effluent limits of municipal NPDES permits. In addition to selfmonitoring requirements imposed by the permits, the city of Tacoma monitors all industries twice yearly. Source control activities that involve the discharge of effluent to Tacoma sanitary sewers must comply with the substantive requirements of the pretreatment program (e.g., discharge limitations and monitoring).

3.2.4 TPCHD/City of Tacoma Storm Drain Program

Pursuant to a memorandum of agreement between Ecology, the city of Tacoma, and the TPCHD, a program was initiated in August 1986 to identify and characterize sources contributing contaminants to several publicly-owned outfalls in Commencement Bay. The program currently focuses on a drainage system at the head of Sitcum Waterway, three drainage networks in City Waterway, and one drainage network in Wheeler-Osgood Waterway.

Tasks undertaken by the program include drainage basin characterization (inspection and documentation of industries and comprehensive drainage basin mapping), quarterly wet weather and dry weather monitoring of storm drain effluent, periodic monitoring of key catch basin sediments, and identification of sources (including roadway contaminant characterization). While most of the program has been completed, it is expected that storm drain monitoring and other activities (e.g., source identification) will continue over the long term.

3.2.5 CERCLA Pre-remedial Program

Various contaminated industrial sites listed in the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) are located within the CB/NT site. Contaminated sites listed in CERCLIS are either CERCLA sites or have the potential to become CERCLA sites. Twenty-six CB/NT CERCLIS sites do not require further action by the federal Superfund pre-remedial program because they are already addressed by non-CERCLA programs. Table 2 summarizes these 26 sites. Of the 26 CB/NT CERCLIS sites, 14 are currently considered to be potential sources of contaminants to the CB/NT problem areas addressed here. They are referred to as CB/NT source control sites in Table 2. Eighteen of the CERCLIS sites are being tracked and managed under non-CERCLA programs by Ecology's Commencement Bay UBAT. Enforcement authorities for these sites are described in Table 1. Eight CERCLIS sites are being managed under non-CERCLA programs by EPA, Ecology (non-UBAT), or TPCHD. Enforcement mechanisms for these eight sites include RCRA and state dangerous waste and county solid waste regulations.

3.2.6 Coordination of Source Control with Other Programs

Existing programs and requirements will provide the basic regulatory framework for the reduction or elimination of ongoing releases of toxic materials to the marine environment. For example, wastewater discharges from industrial and municipal facilities have been and will continue to be regulated under NPDES and state waste discharge permit programs. Releases of hazardous substances have been and will continue to be regulated under state and federal hazardous waste management laws. In most cases, discharge requirements are similar to requirements for comparable facilities in other parts of Puget Sound.

3.3 MAJOR SEDIMENT MANAGEMENT PROGRAMS

The major focus of the CB/NT Record of Decision is to correct sediment contamination problems via source control and sediment remediation. Sediment remediation may occur by natural recovery or sediment confinement. Removal of marginally contaminated sediment outside the designated problem areas may occur irrespective of remediation during routine navigational dredging. Sediment remedial activities in problem areas at the CB/NT site are driven by CERCLA. In addition, routine dredging in problem areas will be subject to the requirements of the multi-

TABLE 2. SITES AT THE COMMENCEMENT BAY NEARSHORE/TIDEFLATS SITE LISTED IN SUPERFUND INFORMATION SYSTEM

CB/NT Source Control Site	CERCLIS Identification Number	Site Name	Managing Agency
•[a]	WAD980738025	B&L Landfill	UBAT[b]
	WAD008958357	Cascade Pole Co., Inc. (McFarland)	Ecology[c]
•	WAD981763162	Cascade Timber Log Sorting Yard #1	UBAT
	WAD988466413	Cascade Timber Log Sorting Yard #2	UBAT
	WAD009281007	Coski Industrial Dump	UBAT
	WAD980514566	Dauphin Site	UBAT
	WAD980639645	Don Oline Landfill	UBAT
	WAD009248774	Georgia-Pacific	UBAT
•	WAD009253295	Louisiana-Pacific Corporation	UBAT
•	WAD980511653	Marine View Drive Site	UBAT
•	WAD089335160	Murray Pacific Log Sorting Yard #1	UBAT
•	WAD009253246	Pennwalt Chemical Corporation	UBAT
	WAD980511711	Petarcik Site	UBAT
•	WAD0676162586	Tacoma Boatbuilding Company	UBAT,Ecology
•	WAD009281403	TAM Engineering	UBAT
	WAD009242025	USG Company	UBAT
•	WAD980639140	USG Company, Hylebos Creek Dumpsite	UBAT
•	WAD981761794	Wasser-Winters Log Sorting Yard	UBAT
	WAD001829522	Allied Chemical Corporation - Tacoma Works	TPCHD
•	WAD083350231	American Plating Company	EPA
•	WAD070046511	Champion International (Simpson Tacoma Kraft)	Ecology
•	WAD001882984	Kaiser Aluminum and Chemical Corporation	Ecology
	WAD027543032	Lilyblad Petroleum, Inc., Sol-Pro	Ecology
•	WAD009242314	Occidental Chemical Corporation	EPA
	WAD009252628	Stauffer Chemical	TPCHD
	WAD009252719	U.S. Oil & Refining Company	Ecology

[a] = Currently considered to be potential sources of contaminants to CB/NT problem areas.

[b] The Commencement Bay Urban Bay Action Team (UBAT) at Washington Department of Ecology's Southwest Regional Office.

[c] Washington Department of Ecology programs other than the Commencement Bay UBAT.

agency Puget Sound Dredged Disposal Analysis (PSDDA). If sediments in problem areas fail criteria for open-water unconfined disposal, sediment remediation will proceed as a CERCLA action.

Dredging and dredged material disposal in Commencement Bay are regulated by Clean Water Act Sections 404 and 401 (i.e., the state water quality certification process), Washington Department of Fisheries and Washington Department of Wildlife (hydraulics permits), Washington Department of Natural Resources (aquatic disposal site permits), city of Tacoma (shoreline substantial development permits), and PSDDA (procedures and guidelines for dredged material and disposal site testing). These authorities address the following aspects of sediment removal and disposal:

- **Clean Water Act Section 404 Permit:** Federal Clean Water Act Section 404 specifies requirements and guidelines for dredging and dredged material management, including designation of disposal sites. The U.S. Army Corps of Engineers (Corps) is responsible for processing and issuing permits under the Section 404 program. Federal guidance specifies procedures and criteria for achieving compliance with guidelines, evaluating and testing dredged material, developing and considering actions to minimize adverse effects, and issuing permits for the disposal of dredged material.
- **Puget Sound Dredged Disposal Analysis Procedures and Guidelines:** The Corps, EPA, Washington Department of Natural Resources, and Ecology have adopted a management plan for dredged material, which is suitable for unconfined open-water disposal, including disposal site locations, site conditions, dredged material evaluation procedures, disposal site management, disposal site monitoring, and dredged material data management (PSDDA 1988). These procedures and guidelines were developed under Clean Water Act Section 404.
- **State Water Quality Certification:** Pursuant to Clean Water Act Section 401, state water quality certification by Ecology is necessary for any project that may cause the violation of a state water quality standard.
- **Washington Department of Fisheries and Washington Department of Wildlife Hydraulics Permit:** Hydraulics permit regulations require the issuance of a hydraulics permit by the Washington Department of Fisheries and Washington Department of Wildlife for any project that may interfere with the natural flow of water.
- **Washington Department of Natural Resources Aquatic Disposal Site Permit:** WAC 332-30-166 establishes a procedure for site selection and a fee structure for site use. General requirements specified in WAC 332-30-166 are mirrored in PSDDA guidelines (see PSDDA Procedures and Guidelines, above).
- **City of Tacoma Substantial Development Permit:** The city of Tacoma has prepared a shoreline management plan pursuant to the state Shoreline Management Act. The Tacoma shoreline management plan establishes environmental designations for shoreline segments within city limits and establishes allowable uses and restrictions, requirements, and limitations for those uses. Shoreline management plan ordinances include provisions for application for a substantial development permit for projects within the shoreline area that are valued at more than $2,500.

Routine navigational dredging actions must meet all substantive and procedural requirements of these permit and certification programs. Sediment removal and disposal actions conducted under CERCLA must meet only the substantive requirements.

CERCLA requirements and procedures will be used to implement sediment remediation, including both monitoring for natural recovery and active remediation (e.g., capping, or removal and disposal). Sediment remediation will be developed in a phased approach according to priorities for action described in the *Commencement Bay Nearshore/Tideflats Integrated Action Plan* (PTI 1988) and clarified in this Record of Decision. Under CERCLA, sediment remedial action will be performed in compliance with the substantive requirements of existing environmental rules and regulations. Routine (i.e., non-CERCLA) sediment removal actions that contribute to the selected remedy must meet all permit requirements.

The sediment cleanup strategy proposed in the CB/NT feasibility study is consistent with and supportive of the major sediment quality management initiatives and programs of PSDDA, the PSWQA plan (PSWQA 1988), and the Puget Sound Estuary Program. Many of the actions proposed for the CB/NT site depend upon the successful implementation of these programs.

3.4 ENFORCEMENT ROLES OF EPA, ECOLOGY, AND THE PUYALLUP TRIBE

This Record of Decision represents a significant transition in agency management and oversight of the CB/NT project. During the remedial investigation/feasibility study phase of the project, Ecology had the lead management role through a cooperative agreement with EPA. Ecology was responsible for developing the remedial investigation/feasibility study and for implementing source control measures for many of the major sources that were identified during the remedial investigation/feasibility study.

In March 1988, a management strategy was developed by EPA and Ecology that was intended to define responsibilities following the Record of Decision. It was agreed that Ecology would maintain the lead for source control because of the multi-programmatic enforcement capability of the Commencement Bay UBAT, and EPA would assume the lead for sediment remedial action because of EPA's experience in managing multi-party cleanup actions.

The dual-lead concept of CB/NT project management was formalized on 30 June 1989 in a cooperative agreement between EPA and Ecology. The agreement provides for an additional level of federal funding to Ecology that will double the size of the Commencement Bay UBAT during the active cleanup phase of the CB/NT project. Under the terms and conditions of the agreement, Ecology assumes responsibility for CB/NT source control actions which are to be implemented under various enforcement authorities in a manner that closely parallels the Superfund process. For example, community relations activities are to be included in accordance with the requirements and guidance of CERCLA and the NCP.

The primary purpose of the cooperative agreement is to significantly enhance the Commencement Bay UBAT's ability to meet the project goals for source control in a timely manner. The agreement is also intended to ensure coordination with other environmental programs that continue to play a key role in successful project implementation (see Section 3). Under the terms and conditions of the agreement, source control will be implemented by Ecology on a facility- or property-specific basis according to the schedule outlined in Section 12.6. Reporting requirements include periodic progress reports and submittal of a final Superfund completion report for each of the eight CB/NT problem areas described in this Record of Decision. Progress reports will be used to update and revise CB/NT implementation schedules on an annual basis. Completion reports will summarize the status of enforcement activities upon completion of source control (see Section 10.3) and will require approval by the EPA Regional Administrator. Adjustments to the agreement and/or utilization of other resources by either agency may be necessary in order to meet the CB/NT objectives for source control.

In contrast, sediment remediation will be implemented in each problem area under EPA oversight. EPA recently conducted a search to identify PRPs for each of the eight CB/NT problem areas of concern. These PRPs were notified of their potential Superfund liability for sediment investigation and cleanup activities in a CERCLA general notice letter issued by EPA in April 1989. The letter requested the PRPs to clarify the status of their involvement at the site and respond to questions regarding the use and disposal of hazardous substances at the site. As appropriate, EPA will pursue CERCLA settlements with PRPs for sediment remediation in each of the problem areas. EPA's legal enforcement and cost recovery efforts for Operable Units 01 and 02 will focus on those PRPs identified by EPA for each of the eight CB/NT problem areas described in this Record of Decision. Owners and operators of businesses and properties within the CB/NT site, but not associated with sediment contamination problems in the eight CB/NT problem areas, will not be issued special notice letters or designated as PRPs in conjunction with this project. EPA may conduct additional investigations or name additional PRPs if new information is received that demonstrates that a party may be liable for response actions described in this Record of Decision.

In addition, some property owners and operators may be notified by Ecology of potential liability for response actions in the tideflats area. In some cases, notification by Ecology may be related to CB/NT source control efforts. Source control actions by Ecology will be very closely coordinated with EPA efforts to clean up sediments in waterways and shoreline areas. In other cases, Ecology may contact property owners and operators in the tideflats area for reasons unrelated to the CB/NT Superfund project.

The role of the Puyallup Tribe of Indians was limited during the remedial investigation/feasibility study phase of the project. As a member of the CB/NT technical oversight committee (see Appendix B, Responsiveness Summary) the tribe's primary role was to review project documents. In 1986, Congress expanded the tribe's CERCLA role under SARA, giving it substantially the same opportunities for project oversight and implementation afforded the state. In response, EPA entered into a Superfund memorandum of agreement (27 April 1989) and a cooperative agreement (28 April 1989) with the tribe that provided for participation as a supporting agency, especially with regard to evaluation and restoration of threatened or impacted natural resources and important habitats within the project boundaries.

3.5 SCHEDULING AND COORDINATION OF SOURCE CONTROL AND SEDIMENT REMEDIAL ACTION

Correction of sediment contamination problems at the CB/NT site will be implemented over a period of several years. In the short term, regulatory efforts will focus on measures to reduce or eliminate the ongoing release of contaminants. These measures, in conjunction with natural processes such as biodegradation and sedimentation, will reduce exposure to contaminated sediments. After source control measures are implemented in a particular problem area, sediment remedial action will be initiated (see Section 10.3).

As indicated in previous sections, correction of sediment contamination problems, including source control, will be implemented by several agencies using a wide variety of existing regulatory authorities. Relationships among the CB/NT project and other federal, state, tribal, and local programs are important jurisdictional considerations during the cleanup phase of the project. For example, during this period it is anticipated that routine dredging projects (i.e., projects not related to Superfund) will continue to occur. The relationships between the CB/NT project and various non-Superfund projects are described in more detail in the feasibility study.

4. HIGHLIGHTS OF COMMUNITY PARTICIPATION

A revised community relations plan was recently completed by EPA, in cooperation with Ecology and TPCHD. The plan summarizes past site activities for all operable units of both the CB/NT and CB/STC Superfund sites since 1981 when both sites were incorporated as the Commencement Bay site. The plan also describes ongoing community concerns and outlines agency plans for present and future community involvement.

The agencies interviewed community members in 1983 to determine community concerns, and to plan community relations activities and opportunities for public involvement. In 1987, the agencies interviewed 30 additional persons to reassess community interest and concerns, and to revise the community relations plan.

The most interested groups, on a continuing basis, have been local officials, the Puyallup Tribe of Indians, local businesses, local environmental and citizens groups, and other federal, state, and local agencies. The most consistent community involvement has come from a Citizens Advisory Committee and a Technical Oversight Committee.

Media and community interest in the CB/NT site increased as the feasibility study neared completion, focusing on the costs, benefits, and other considerations of cleanup. At the request of several parties, the agencies planned for a 120-day public comment period on the CB/NT feasibility study and proposed plan. The agencies held two formal public meetings while agency site managers met with over 20 interest groups. The public meeting transcripts are in the Administrative Record. The Citizens Advisory Committee attracted approximately 50 people to a citizens workshop designed to inform community members about these projects. During the public comment period, EPA and Ecology established an information booth at the Tacoma Fire Department Fireboat Station. Agency representatives were available at the booth one day per week to answer questions from members of the community. During this period, the print, radio, and television media increased their coverage of the issues.

The CB/NT remedial investigation (Tetra Tech 1985) was published in August 1985. The CB/NT feasibility study (Tetra Tech 1988a) including the integrated action plan (PTI 1988), the sediment quality goals report (PTI 1989), and the proposed plan were released to the public in February 1989. Ecology and EPA have met the statutory public participation requirements of SARA Section 117 by:

- Establishing 5 main and 12 satellite information repositories and making the administrative record of site information available at the Tacoma Public Library main branch (near the site)
- Publishing a notice and brief analysis of the proposed plan in the Tacoma News Tribune on 24 February 1989
- Providing a 120-day public comment period (from 24 February 1989 until 24 June 1989) on the proposed plan and cleanup alternatives
- Holding two public meetings during the public comment period at the Tacoma Yacht Club, transcripts of which were placed in the information repositories and administrative record
- Considering and responding to comments when selecting the remedy. (A summary of significant comments and responses is included in Appendix B. Significant changes from the proposed plan and the reasons for such changes are described in Section 12.)

EPA will publish a notice of the final remedial action plan in the Tacoma News Tribune and will mail a fact sheet describing the plan to the mailing list of interested persons within 30 days of signing this document.

The agencies will continue to encourage public involvement and provide information about site activities. For example, the agencies will continue to maintain information repositories to ensure that relevant documents and information are conveniently available for public review. The agencies also will maintain the mailing list and send periodic fact sheets describing ongoing activities. The Citizens Advisory Committee is continuing to meet. EPA and Ecology will provide the committee with information and attend meetings as requested. Agency representatives also will meet with other groups of interested citizens as requested.

In recognition of the scope and complexity of the CB/NT site, EPA is establishing a Technical Discussion Group for the remedial design and remedial action phase, and to integrate and expand the information exchange of the Technical Oversight Committee and Citizens Advisory Committee. Membership of the Technical Discussion Group is intended to include the CB/NT site management team, representatives of regulatory agencies and programs, PRPs, local government, interested citizens, and organized citizens groups. The Technical Discussion Group will provide a forum for the general review of technical and planning issues during the cleanup phase of the project. Discussion topics may include a wide range of issues related to project status, planning, sediment management and habitat concerns, health issues, and local development. It is hoped that the Technical Discussion Group will provide EPA with valuable insight into issues of concern, and thereby contribute to project direction and findings. However, group input will not form EPA policy or determine EPA's course of action, nor will it preclude the 30-day public comment period required upon completion of negotiated agreements between EPA and PRPs for sediment cleanup in each of the problem areas. Meetings will be scientific and technical in nature; legal matters will not be discussed.

In addition, most source control activities will include public involvement as part of the project implementation. For example, major source control enforcement actions conducted by Ecology under the state's Model Toxics Control Act, and other actions requiring permits, will include formal public comment periods. The CB/NT cooperative agreement with EPA also requires Ecology to conduct community relations activities in accordance with CERCLA and the NCP.

5. SCOPE OF RESPONSE ACTION WITHIN OVERALL SITE STRATEGY

This Record of Decision is final and comprehensive for two of the six operable units at the CB/NT site, Operable Unit 05 (Source Control), and Operable Unit 01 (Sediment Remediation). All six operable units, including the Tacoma tar pits and three ASARCO-related projects, are described in the following subsection. The purpose of CB/NT response actions addressed in this Record of Decision is to mitigate or correct impacts directly associated with contaminated marine sediments in the CB/NT site. The Record of Decision is therefore focused on contaminated sediments, contaminant sources, impacts to marine organisms, and specific human exposure pathways (i.e., consumption of seafood and dermal contact with sediment). However, the CB/NT Superfund project is not intended to address other types of environmental or public health problems within the site boundaries that should be adequately covered by other federal, state, tribal, or local programs. Problems not within the scope of the CB/NT project include contaminated properties and sources within the site boundaries that do not appear to impact marine sediments.

The scope of the CB/NT response action is also distinct from other federal Superfund projects that were originally combined in the Commencement Bay investigation in October 1981. The Commencement Bay site was divided into four areas: deepwater, nearshore, tideflats and south Tacoma channel. Subsequently the deepwater area was eliminated as a priority site because water quality studies indicated less severe contamination in that area than was originally suspected. The remaining areas have been separated into two discrete Superfund sites since December 1982, the CB/NT site and the CB/STC site.

The CB/STC site, located approximately 3 miles southwest of City Waterway, includes three projects: Well 12A, the Tacoma municipal landfill, and the Tacoma swamp. Although there is no apparent groundwater connection between the two Commencement Bay Superfund sites, there is a surface water link. A major storm drain network directs surface water runoff from the CB/STC site to the head of City Waterway. However, none of the CB/STC projects are currently considered a significant source of contaminant loading in the CB/NT site.

5.1 SCOPE AND ROLE OF COMMENCEMENT BAY NEARSHORE/TIDEFLATS OPERABLE UNITS

Superfund response actions at the CB/NT site are currently coordinated under six separate operable units. The six operable units constitute a comprehensive remedial response to actual or threatened releases of hazardous substances that are associated with the Tacoma tar pits, the ASARCO Tacoma smelter, and the CB/NT marine environment. The six CB/NT operable units are listed below:

- Operable Unit 01 - CB/NT Sediments
- Operable Unit 02 - ASARCO Tacoma Smelter
- Operable Unit 03 - Tacoma Tar Pits
- Operable Unit 04 - ASARCO Off-Property
- Operable Unit 05 - CB/NT Sources
- Operable Unit 06 - ASARCO Sediments.

The CB/NT operable units have been designated by EPA over the course of several years in response to changing project needs as the agencies develop a better understanding of the overall CB/NT site. The numbering sequence used to identify each operable unit is simply chronological.

For example, Operable Unit 06 was established most recently. The role of the CB/NT operable units within the overall site strategy has been redefined and adjusted by EPA management during the public comment period for the CB/NT feasibility study, as described below. For each operable unit either EPA or Ecology is described as the lead oversight agency. In each case, when one agency is the lead agency, the other acts as a supporting agency.

5.1.1 Operable Unit 01 - Commencement Bay Nearshore/Tideflats Sediments

Until recently Operable Unit 01 was described as CB/NT *Areawide*, which referred to the entire site, exclusive of the Tacoma tar pits and ASARCO-related upland projects. Operable Unit 01 included response actions designed to combine both source control and sediment remediation to address problems related to contaminated marine sediments throughout the site. Thus the CB/NT remedial investigation/feasibility study, for which Ecology had the lead management responsibility, characterized and evaluated sources as well as sediment problems within the site. In March 1988, EPA and Ecology developed a management strategy designed to take maximum advantage of agency resources during continued response actions at the site. That strategy identified Ecology as the lead agency for continued source control efforts and EPA as the lead agency for subsequent sediment remediation. As a result, Operable Unit 01 was redefined to include response actions related to sediment remediation, and Operable Unit 05 was created to address source control activities.

This Record of Decision confirms the CB/NT site boundaries described in the CB/NT feasibility study and serves as the blueprint for further response actions within the site. As stated in the CB/NT remedial investigation/feasibility study, sediment contamination problems in low priority areas of the site do not appear to warrant further action under the federal Superfund program. Therefore, while the CB/NT site boundaries remain unchanged, continued response actions governed by this Record of Decision are limited to source control and sediment remediation within the priority areas defined in the CB/NT feasibility study.

Response actions governed by this Record of Decision are further limited to eight of the nine CB/NT problem areas that were defined in the remedial investigation/feasibility study. As described below under Operable Unit 06, a final decision regarding the Ruston-Pt. Defiance Shoreline problem area is deferred entirely to the subsequent ASARCO Sediments (Operable Unit 06) Record of Decision.

Oversight management of Operable Units 01 and 05 will be coordinated by EPA, Ecology and the Puyallup Tribe. Remedial design and remedial action tasks will be tracked separately for source control and sediment remediation in each of the eight CB/NT problem areas addressed in this Record of Decision. The management strategy for the site identifies Ecology as the lead agency for source control, EPA as the lead agency for sediment remediation, and the Puyallup Tribe as a supporting agency for continuing response actions with a particular focus on natural resource issues. Cooperative agreements defining these relationships were reached between EPA and the Puyallup Tribe on April 29, 1989 and between EPA and Ecology on June 30, 1989. These three agencies will share responsibility for coordination with other ongoing and related programs, as described in Section 5.4, Enforcement Coordination.

5.1.2 Operable Unit 02 - ASARCO Tacoma Smelter

Arsenic and other hazardous substances contaminate the ASARCO Tacoma smelter site, private and public properties in the surrounding community, and the adjacent shoreline. Stack emissions, slag, and fugitive dust from the ASARCO facility are the confirmed sources of contaminants. The smelter operated for almost 100 years before closing in 1985 for economic reasons. ASARCO, Inc., the current owner and former operator of the smelter, has agreed to the terms of an EPA administrative consent order (September 1986) to conduct a remedial investigation/feasibility study for the facility.

The remedial investigation for the ASARCO facility was completed in July 1989, and the public review draft of the feasibility study is to be completed in October 1989. Both reports include significant new information regarding marine sediment problems near the ASARCO facility. A Record of Decision for Operable Unit 02, including plans for cleanup and stabilization of the site, is expected to be completed this year. EPA is the lead oversight agency for the ASARCO facility.

5.1.3 Operable Unit 03 - Tacoma Tar Pits

The Tacoma tar pits, an historical coal gasification site located near the mouth of the Puyallup River, was operational from the 1920s through 1956. The site is currently used as a scrap metal yard. Contaminants including tar wastes (PAHs), PCBs, and heavy metals have been found in site soils, surface water, and groundwater. A Record of Decision for the site, completed in December 1987, called for a combination of excavation and treatment of the most highly contaminated soils, capping of the remaining areas of the site and continued monitoring of groundwater near the site. The site is now in the remedial design phase with remedial action expected to begin in 1991. EPA is the lead oversight agency for the Tacoma tar pits.

5.1.4 Operable Unit 04 - ASARCO Off-Property

Federal, state, and local environmental and public health agencies have conducted extensive studies to determine the risks associated with arsenic exposure in areas surrounding the ASARCO Tacoma smelter. An exposure pathways study identified young children as the population most at risk and contaminated soils as the medium of highest concern. In March 1989, ASARCO agreed to an EPA consent order requiring the company to perform an expedited response action at 11 publicly accessible off-property areas. The expedited response action will provide cleanup and capping of the areas and will be followed by a more comprehensive remedial investigation/feasibility study of off-property problems in the surrounding area. EPA has the lead oversight role for the ASARCO off-property response actions.

5.1.5 Operable Unit 05 - Commencement Bay Nearshore/Tideflats Sources

The identification and control of sources of contamination in the marine environment at the CB/NT site is recognized as the most challenging and critical component of the overall response strategy. Ecology's Commencement Bay UBAT has been established in direct response to this challenge. Although the action team operates within a jurisdictional area that exceeds the CB/NT site boundaries, its enforcement activities have focused on major sources within CB/NT priority problem areas since publication of the CB/NT remedial investigation in August 1985. The action team's role in the CB/NT Superfund project is clearly defined in the cooperative agreement for source control awarded to Ecology by EPA on June 30, 1989. That role is specifically limited to activities that pose an actual or potential threat to marine sediments in the eight problem areas governed by this Record of Decision. Ecology is the lead oversight agency for Operable Unit 05 (Sources).

5.1.6 Operable Unit 06 - ASARCO Sediments

The Ruston-Pt. Defiance Shoreline problem area described in the feasibility study has been designated Operable Unit 06. This change reflects new information received during the public comment period. At that time, the agencies received as public comment a remedial investigation for the ASARCO Tacoma smelter and off-shore sediments. This report included detailed new information about characteristics, areal extent, and volume of contaminated sediments along the Ruston-Pt. Defiance Shoreline. The agencies have reviewed this information and believe that further detailed analysis of remedial alternatives for this problem area is needed. The new information submitted during the comment period indicates that sediment toxicity problems associated with coarse-grained slag particles in this problem area may be less severe than predicted in the CB/NT feasibility study. Therefore, significant changes regarding the estimated volume of contaminated sediments, the preferred sediment remedial alternative, and the cost of this remedy can be anticipated.

The portion of the CB/NT feasibility study for the Ruston-Pt. Defiance Shoreline problem area is currently being revised. Once the agencies have re-evaluated the feasible remedial alternatives for this problem area, EPA and Ecology will issue a new proposed plan for a 30-day public comment period. After consideration of public comments, the agencies will select a remedy for the operable unit and issue another Record of Decision specific to the CB/NT Ruston-Pt. Defiance Shoreline problem area.

5.2 COORDINATION OF OPERABLE UNITS 05 (SOURCES) AND 01 (SEDIMENTS)

Operable Unit 05 (Source Control) and Operable Unit 01 (Sediment Remediation) are addressed in a single Record of Decision because these two response activities must be closely coordinated to ensure successful implementation of the overall site remedy. Sediment remedial action cannot proceed until major sources of contamination have been controlled, because ongoing sources could recontaminate clean sediments exposed by dredging or laid down as capping material. Comprehensive source control as defined by this Record of Decision is essential to ensure that the overall remediation is permanent. Consequently, source identification and control programs are ongoing and will continue beyond the completion of remedial actions.

6. SITE CHARACTERISTICS

Hazardous substances and waste materials have been released into the Commencement Bay environment since the beginning of industrial activity in the area. As a result of various uses and releases of waste materials, the chemical quality of the waters and sediments in many areas of Commencement Bay has been altered. Contaminants found in the area include arsenic, lead, zinc, cadmium, copper, mercury, and various organic compounds such as PCBs and PAHs.

Contaminants in the CB/NT area originate from both point and nonpoint sources. Industrial surveys conducted by the TPCHD and the Port of Tacoma indicate that there are more than 281 active industrial facilities in the CB/NT area. Approximately 34 of these are NPDES-permitted dischargers, including two sewage treatment plants. Nonpoint sources include two creeks; the Puyallup River; numerous storm drains, seeps, and open channels; groundwater seepage; atmospheric deposition; and spills. The TPCHD has identified approximately 480 point and nonpoint sources that empty into the CB/NT area (Rogers et al. 1983). The network of channels, streams, and pipelines discharging to the CB/NT site is illustrated in Figure 3.

The primary objective of the remedial investigation was to define the nature and extent of sediment contamination. That investigation involved the compilation and evaluation of existing data and an extensive field sampling effort to collect additional data. The CB/NT database developed during the remedial investigation consisted of 23 data files, each storing a different kind of data. Data of different kinds were linked together by common identifiers (e.g., survey, station, drainage). At the conclusion of the remedial investigation, the database contained over 25,000 records, each consisting of 15-150 separate variables. There were descriptions of over 50 surveys, 500 sampling stations, and 2,000 samples of water, solids, and biota. Over 400 components of the Commencement Bay drainage system had been identified. Included were data on sediment and water column chemistry, bioassays, benthic invertebrates, fish pathology, and bioaccumulation. All data were subjected to rigorous quality assurance procedures before entering the database. The distribution of sediment contaminants is described in detail in the remedial investigation report (Tetra Tech 1985).

There is considerable variation in the types and concentrations of chemical contaminants in CB/NT sediments. Investigations of the nearshore waters of Commencement Bay have demonstrated the existence of sediment contamination by toxic pollutants, accumulation of some of these substances by biota, and possible pollution-associated abnormalities in indigenous biota (Crecelius et al. 1975; Riley et al. 1980, 1981; Malins et al. 1980, 1982; Gahler et al. 1982; Tetra Tech 1985, 1988b; Parametrix 1987). The highest concentrations of certain metals (i.e., arsenic, copper, lead, and mercury) have been found in sediments in the waterways, along the southwest shore, and near the ASARCO smelter. Sediment contamination by persistent organic compounds (e.g., PCBs), was detected in the heavily industrialized waterways (e.g., Hylebos Waterway) and along the Ruston-Pt. Defiance Shoreline.

During the CB/NT remedial investigation, four inorganic and six organic contaminants were detected at concentrations 1,000 times as great as reference conditions (i.e., conditions in sediments from nonindustrialized areas of Puget Sound). Those concentrations were detected in samples from stations located off the Ruston-Pt. Defiance Shoreline, Hylebos Waterway, and St. Paul Waterway. Twenty-eight chemicals or chemical groups had concentrations 100-1,000 times as great as reference conditions. Contaminants of concern include metals (e.g., arsenic, lead, mercury, zinc), PCBs, and PAHs.

Sediments in many parts of the CB/NT area contain concentrations of one or more toxic contaminants that exceed levels commonly found in Puget Sound reference areas. During the remedial investigation, a multistep decision-making process was used to 1) define problem sediments and identify areas containing problem sediments, 2) identify problem chemicals, and 3)

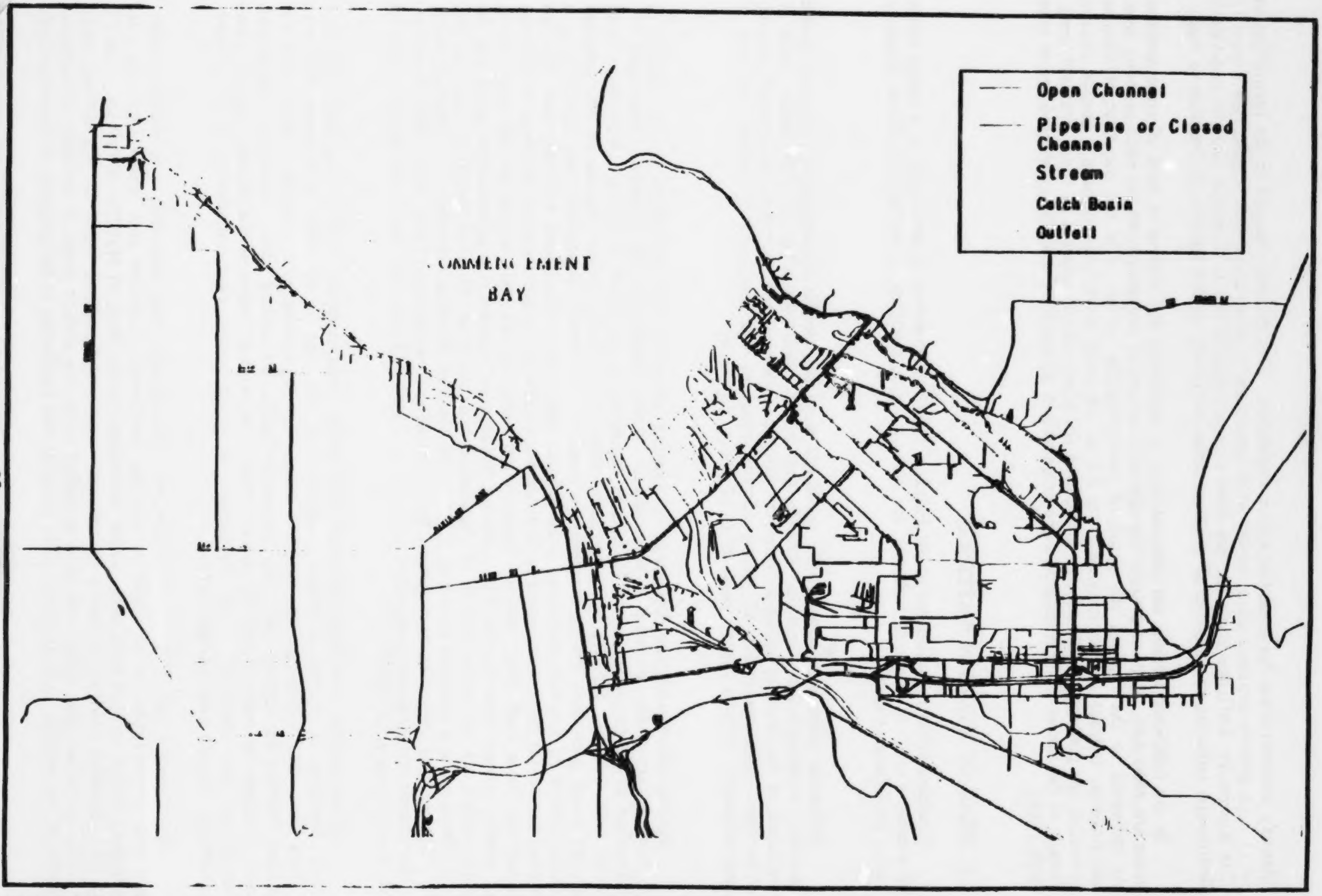

Open Channel
Pipeline or Closed Channel
Stream
Catch Basin
Outfall
COMMENCEMENT BAY

Figure 3. Commencement Bay drainage network

identify problem areas for remedial action evaluation. This process resulted in the identification of 11 high priority problem areas, which were subsequently consolidated into 9 areas (see Figure 1). The Ruston-Pt. Defiance Shoreline has been recently established as Operable Unit 06 (ASARCO Sediments) reducing the number of problem areas addressed in this Record of Decision to eight.

In the following section, the characteristics of sediments and sources in each of these problem areas are described. Figures present the estimated extent of contamination for each problem area. As indicated in the figures, the depth of contamination varies. For the purposes of volume calculations, average depths ranging from 0.5 to 2.5 yards have been utilized. Source control activities are planned, underway, or completed for many of the sources in these problem areas. Details of the status of these activities are presented in Appendix C and the integrated action plan (PTI 1988).

6.1 HEAD OF HYLEBOS WATERWAY

Contamination in sediments at the Head of Hylebos Waterway is attributed to a broad range of sources including chemical factories, log sorting yards, landfills in the Hylebos Creek drainage basin, and storm drains.

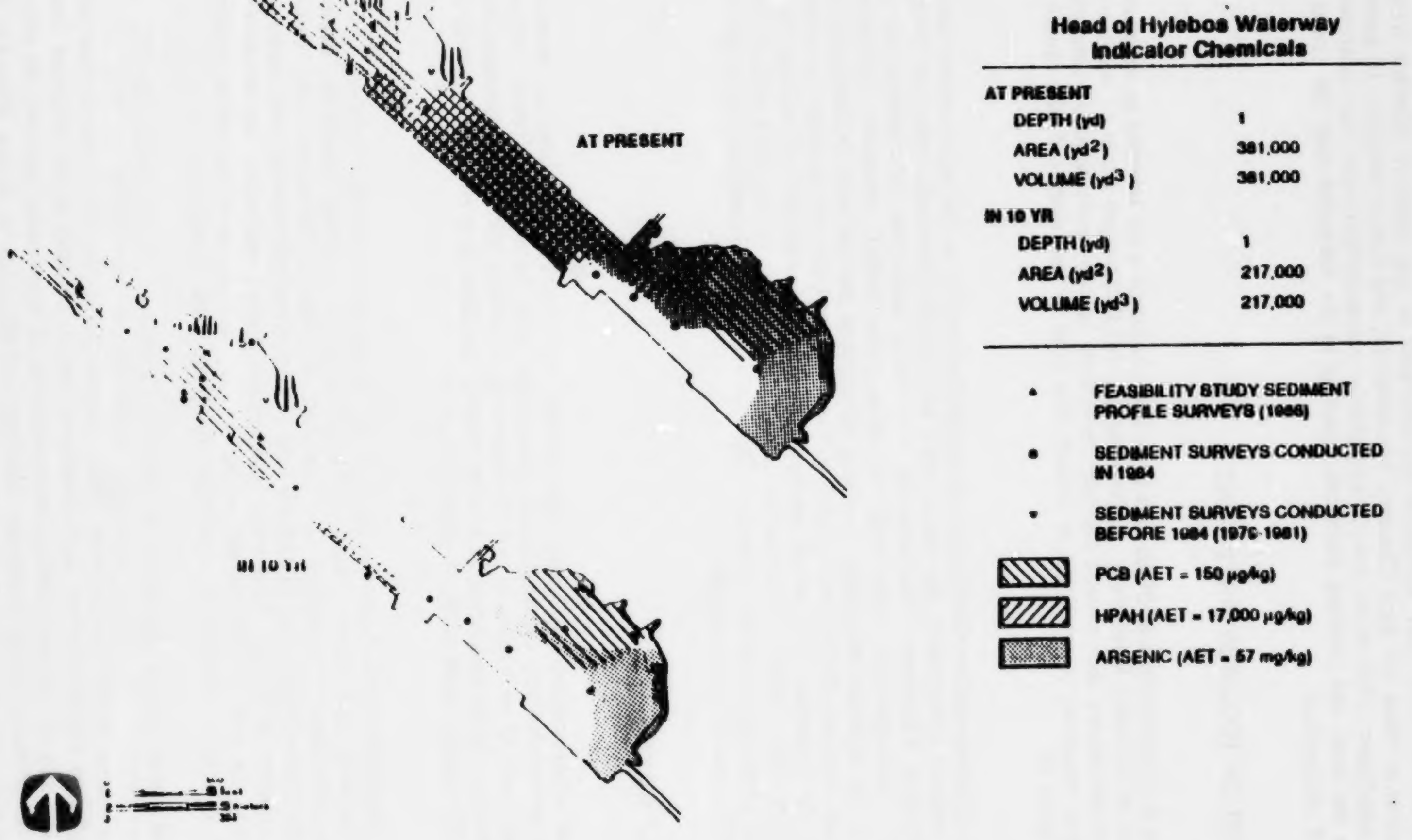
Sediment Characteristics—Three chemicals were selected as indicators of the most severe sediment contamination: arsenic, HPAHs, and PCBs. Approximately 381,000 square yards of sediments at the Head of Hylebos Waterway exhibited chemical concentrations that exceed cleanup objectives. Implementation of source control measures was predicted to reduce this area to approximately 217,000 square yards after 10 years (Figure 4).

Source Characteristics—Locations of existing industries and businesses in the vicinity of Hylebos Waterway are presented in Appendix C. Kaiser Aluminum and Chemical Corporation was identified as the major source of HPAHs in sediments at the Head of Hylebos Waterway (Tetra Tech 1985, 1988a). HPAHs were associated with the historical onsite disposal of wet scrubber sludge waste generated during air emission controls. Pennwalt Corporation was identified as a major source of arsenic (associated with arsenic pesticides), chlorinated hydrocarbons, and low molecular weight polycyclic aromatic hydrocarbons (LPAHs) in sediments at the Head of Hylebos Waterway (Tetra Tech 1985, 1988a). Groundwater seeps and the main outfall are the major points of arsenic release from the facility. Loading calculations indicate that groundwater seeps and the main outfall are the major sources of chlorinated hydrocarbons. General Metals of Tacoma, Inc. was identified as a potential source of PCBs in the Head of Hylebos Waterway. An ongoing source of PCBs was not identified during the CB/NT remedial investigation (Tetra Tech 1985); however, a subsequent reconnaissance survey found high levels of PCBs in catch basin sediments at General Metals (Stinson et al. 1987).

Various sources have been associated with metal contamination. Log sorting yards that have been identified as sources of arsenic, copper, lead, and zinc in the Head of Hylebos Waterway (Tetra Tech 1985, 1988a) include the 3009 Taylor Way log sorting yard, Cascade Timber Yard #2, Wasser Winters log sorting yard, and Louisiana-Pacific log sorting yard. ASARCO smelter slag used as ballast for many of the log sorting yards is the original source of the metals. Surface water runoff has been identified as the mechanism by which metals were transported to the adjacent sediments (Norton and Johnson 1985).

B&L Landfill and USG Landfill (formerly U.S. Gypsum) were associated with arsenic, copper, and lead in sediments at the Head of Hylebos Waterway. Leachate and runoff from the sites transport metals to Hylebos Creek, which discharges to the Head of Hylebos Waterway. The fill at B&L Landfill consists primarily of soil and wood waste scraped from the log sorting yards. ASARCO smelter slag, which was used as ballast at the log sorting yards, is probably the original source of the metals. Arsenic from USG Landfill was attributed to the disposal of baghouse dust.

Reproduced from
best available copy.


AT PRESENT
IN 10 YR
Head of Hylebos Waterway
Indicator Chemicals
AT PRESENT
DEPTH (yd) 1
AREA (yd²) 381,000
VOLUME (yd³) 381,000
IN 10 YR
DEPTH (yd) 1
AREA (yd²) 217,000
VOLUME (yd³) 217,000
FEASIBILITY STUDY SEDIMENT PROFILE SURVEYS (1986)
SEDIMENT SURVEYS CONDUCTED IN 1984
SEDIMENT SURVEYS CONDUCTED BEFORE 1984 (1976-1981)
PCB (AET = 150 μg/kg)
HPAH (AET = 17,000 μg/kg)
ARSENIC (AET = 57 mg/kg)

Tetra Tech (1988a)

Figure 4. Sediments at the Head of Hylebos Waterway not meeting sediment quality objectives for indicator chemicals at present and 10 years after implementing feasible source control

Tacoma Boatbuilding Company may be associated with problem metals in sediments at the Head of Hylebos Waterway. Metals from the site probably originated from sandblasting and painting.

Several storm drains may discharge contaminants to the Head of Hylebos Waterway. The most important of these are East Channel, Morningside, and Kaiser ditches. In general, problem chemicals associated with these drains are poorly characterized, and the relationships among activities in the basin and problem chemicals observed in the sediments near the points of discharge are not well understood.

6.2 MOUTH OF HYLEBOS WATERWAY

Sediment Characteristics—PCBs and hexachlorobenzene were selected as chemical indicators at the Mouth of Hylebos Waterway. Approximately 393,000 square yards of sediments exhibited chemical concentrations that exceed cleanup objectives in this problem area. Implementation of source control measures is predicted to reduce this area to less than 115,000 square yards after 10 years (Figure 5).

Source Characteristics—Occidental Chemical Corporation is the major source associated with chlorinated organic compounds, the major class of problem chemicals found in sediments at the Mouth of Hylebos Waterway. The locations of existing industries and business are provided in Appendix C. Groundwater seeps and the main plant outfall transport chlorinated organic compounds to the adjacent sediments. Loading calculations indicate that groundwater seeps are the most important sources (Tetra Tech 1985). Chlorinated organic compounds in groundwater are attributed to the historical disposal of wastes from solvent production in unlined lagoons on the site (Tetra Tech 1985, 1988a). Chlorinated organic compounds in the main outfall are associated with effluent from the chlorine stripper. The main outfall is classified as a major industrial discharge under the NPDES program.

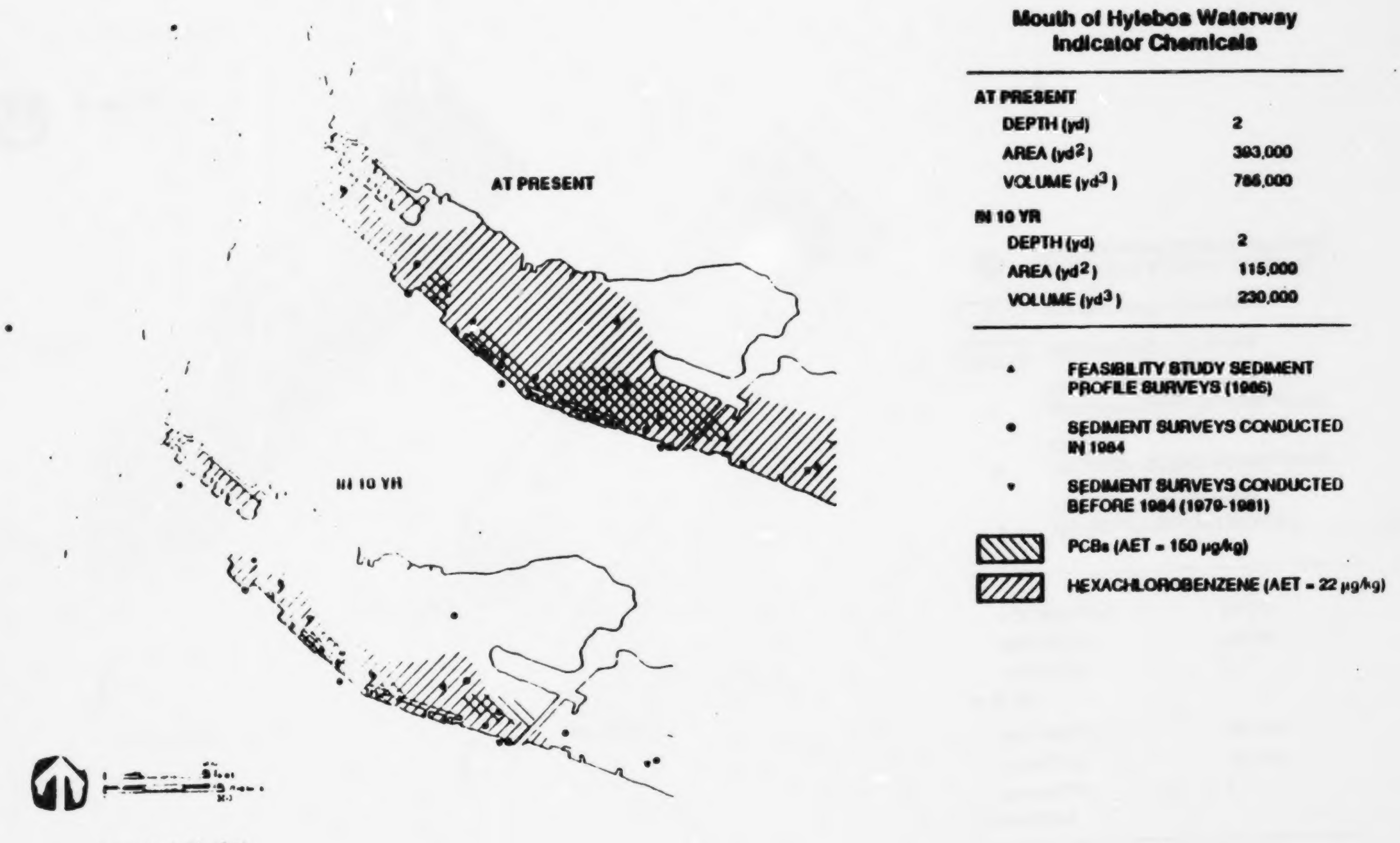
6.3 SITCUM WATERWAY

Sediment Characteristics—Copper and arsenic were selected as chemical indicators of the most severe environmental contamination associated with biological effects. Approximately 167,000 square yards of sediments in this problem area exhibited chemical concentrations exceeding cleanup objectives. Implementation of source control measures is predicted to reduce this area to less than 66,000 square yards after 10 years (Figure 6).

Source Characteristics—Contamination in the sediments of Sitcum Waterway is attributed to ore loading facilities and storm drains. The locations of existing industries, businesses, and discharges are provided in Appendix C. The Port of Tacoma Terminal 7 ore loading facility (which includes Storm Drains SI-168 and SI-169) is associated particularly with metal contamination in the sediments of Sitcum Waterway. Ore spilled during unloading and transfer operations and runoff from the site are the sources of the metals. Spilled ore is no longer washed into the waterway but instead is collected in a sweeper truck and sold to smelters.

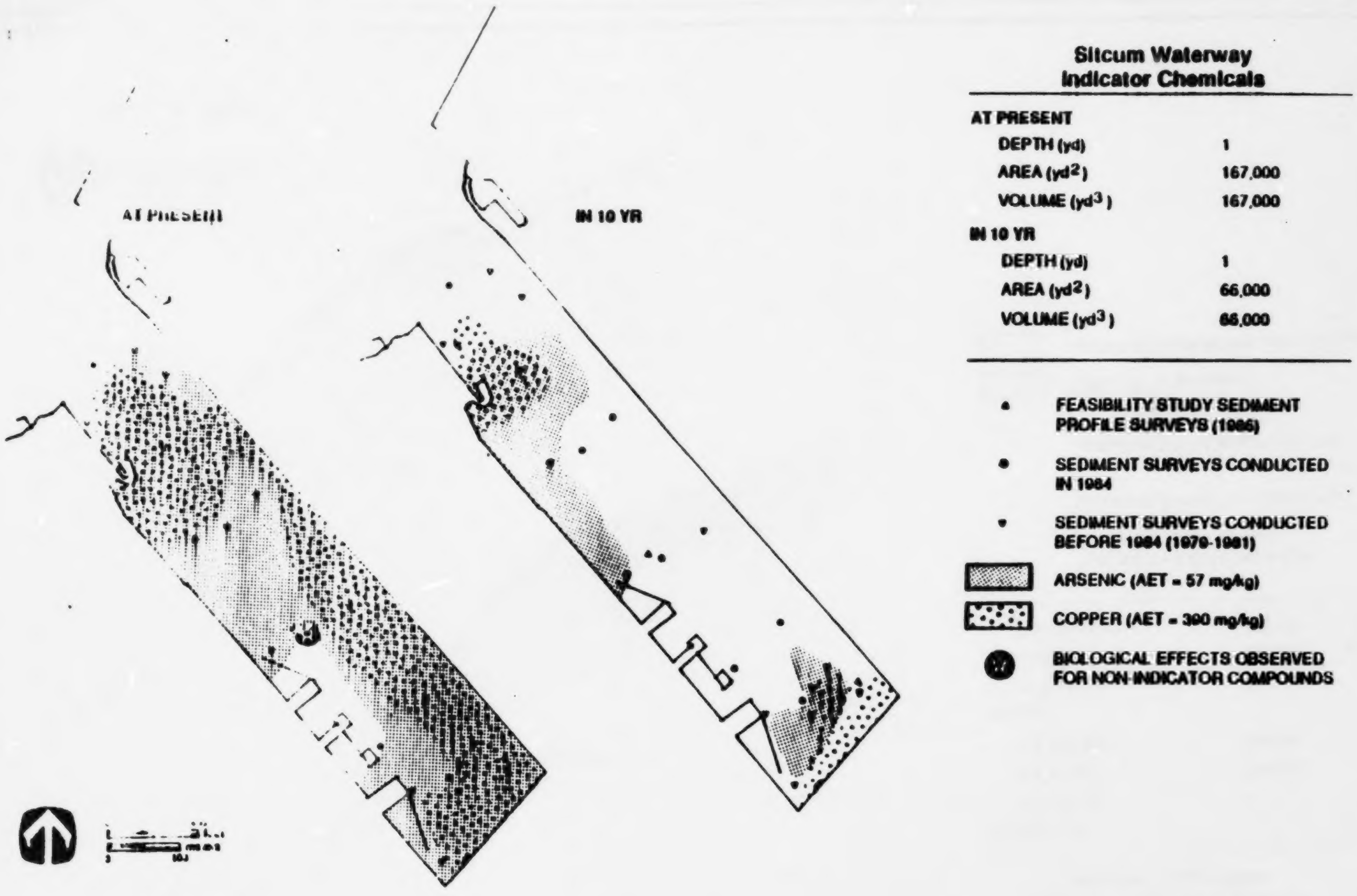
Numerous storm drains discharge to Sitcum Waterway. Storm Drain SI-172, the largest (serving approximately [illegible]70 acres), has been identified as the source of most of the metals contributed by storm drains (Tetra Tech 1985). Storm Drain SI-172 is one of five major storm drains discharging to Commencement Bay waterways that is included in the pollution control effort underway by the city of Tacoma under a memorandum of agreement between the city, TPCHD, and Ecology. Other storm drains potentially discharge contaminants to Sitcum Waterway via runoff. The most important of these is Storm Drain SI-176, which may contribute remaining waste material from the Milwaukee railroad yard located in its drainage basin. In general, problem chemicals

Reproduced from best available copy.


Mouth of Hylebos Waterway
Indicator Chemicals
AT PRESENT
DEPTH (yd) 2
AREA (yd2) 393,000
VOLUME (yd3) 786,000
IN 10 YR
DEPTH (yd) 2
AREA (yd2) 115,000
VOLUME (yd3) 230,000
FEASIBILITY STUDY SEDIMENT PROFILE SURVEYS (1986)
SEDIMENT SURVEYS CONDUCTED IN 1984
SEDIMENT SURVEYS CONDUCTED BEFORE 1984 (1979-1981)
PCBs (AET = 150 μg/kg)
HEXACHLOROBENZENE (AET = 22 μg/kg)
AT PRESENT
IN 10 YR

Tetra Tech (1986a)

Figure 5. Sediments at the Mouth of Hylebos Waterway not meeting sediment quality objectives for indicator chemicals at present and 10 years after implementing feasible source control


AT PRESENT
IN 10 YR
Sitcum Waterway
Indicator Chemicals
AT PRESENT
DEPTH (yd) 1
AREA (yd²) 167,000
VOLUME (yd³) 167,000
IN 10 YR
DEPTH (yd) 1
AREA (yd²) 66,000
VOLUME (yd³) 66,000
FEASIBILITY STUDY SEDIMENT PROFILE SURVEYS (1986)
SEDIMENT SURVEYS CONDUCTED IN 1984
SEDIMENT SURVEYS CONDUCTED BEFORE 1984 (1979-1981)
ARSENIC (AET = 57 mg/kg)
COPPER (AET = 390 mg/kg)
BIOLOGICAL EFFECTS OBSERVED FOR NON-INDICATOR COMPOUNDS

Tetra Tech (1988a)

Figure 6. Sediments in Sitcum Waterway not meeting sediment quality objectives for indicator chemicals at present and 10 years after implementing feasible source control

associated with these drains are poorly characterized, and the relationships between activities in the basin and problem chemicals observed in the sediments in Sitcum Waterway are not well understood.

6.4 ST. PAUL WATERWAY

Sediment Characteristics—Problem chemicals in St. Paul Waterway were mainly organic chemicals. 4-Methylphenol was selected as an indicator chemical. Approximately 118,000 square yards of sediments exhibited levels of 4-methylphenol that exceeded cleanup objectives. Contaminated sediments were capped in place in 1988. Habitat restoration in the intertidal zone was conducted during capping operations.

Source Characteristics—Historical discharges from what is now known as the Simpson Tacoma Kraft pulp mill was the major source of problem chemicals found in the sediments of St. Paul Waterway. The locations of existing businesses, industries, and discharges are presented in Appendix C. The primary historical source of contamination from the site appears to have been effluent from the wastewater treatment system. Extensive remedial action has occurred at the Simpson facility. In-plant process modifications that improved effluent quality and relocation of the secondary treatment outfall were completed in September 1988. Relocation of the outfall and consequent increase in the dilution ratio are predicted by Simpson to virtually eliminate sediment accumulation of any problem chemicals that have not been removed from the effluent stream by in-plant process modifications. Monitoring results will be used to verify this prediction.

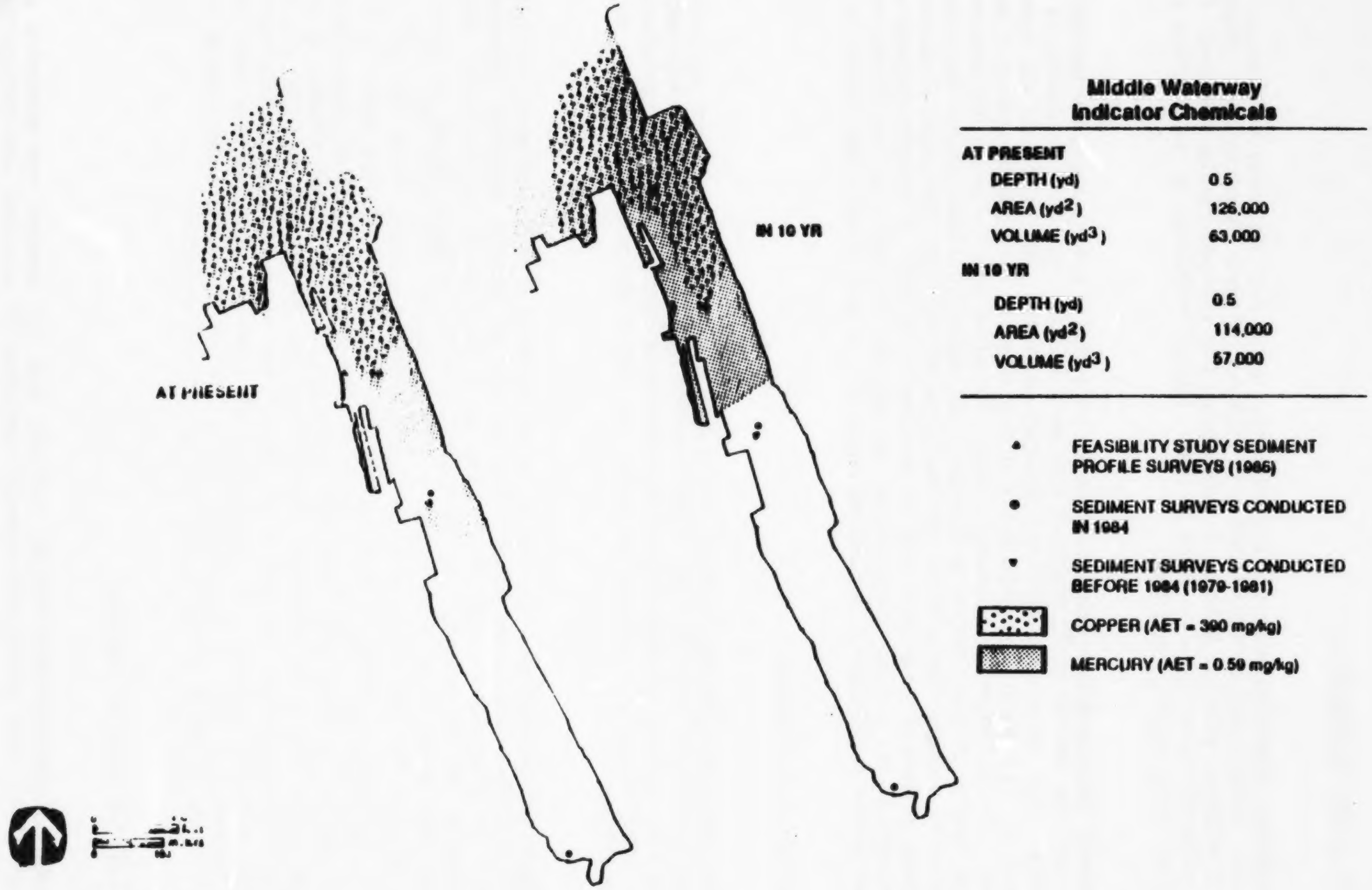
6.5 MIDDLE WATERWAY

Sediment Characteristics—Mercury and copper were selected as chemical indicators of the most severe sediment contamination. Approximately 126,000 square yards of sediments in this problem area exhibited chemical concentrations exceeding cleanup objectives. Implementation of source control measures is predicted to reduce this area to less than 114,000 square yards after 10 years (Figure 7).

Source Characteristics—Contamination in the sediments of Middle Waterway is attributed to maritime industries and storm drains. The locations of existing industries, businesses, and discharges are presented in Appendix C. Land use in the drainage basin is entirely commercial and industrial. Marine Industries Northwest and Cooks Marine Specialties are the two shipyards associated with problem metals in sediments in Middle Waterway (Tetra Tech 1985, 1988a). Metals from these sites are probably derived from sandblasting and painting. Both sites are located on property previously occupied by Foss Launch and Tug and by Peterson Boat, where similar activities were conducted dating back to the 1900s. The largest of the storm drains discharging to Middle Waterway is Storm Drain MD-200, which drains an area of approximately 80 acres and discharges to the head of the waterway. Storm Drain MD-200 has been identified as a probable source of problem organic chemicals in the head of the waterway. Several other storm drains discharge to Middle Waterway. In general, problem chemicals associated with these drains are poorly characterized, and the relationships among activities in the basin and problem chemicals observed in the sediments in Middle Waterway are not well understood.

6.6 HEAD OF CITY WATERWAY

Sediment Characteristics—HPAHs, cadmium, lead, and mercury were selected as chemical indicators of the most severe environmental contamination associated with biological effects.


AT PRESENT
IN 10 YR
Middle Waterway
Indicator Chemicals
AT PRESENT
DEPTH (yd) 0.5
AREA (yd2) 126,000
VOLUME (yd3) 63,000
IN 10 YR
DEPTH (yd) 0.5
AREA (yd2) 114,000
VOLUME (yd3) 57,000
FEASIBILITY STUDY SEDIMENT PROFILE SURVEYS (1986)
SEDIMENT SURVEYS CONDUCTED IN 1984
SEDIMENT SURVEYS CONDUCTED BEFORE 1984 (1979-1981)
COPPER (AET = 390 mg/kg)
MERCURY (AET = 0.59 mg/kg)

Tetra Tech (1988a)

Figure 7. Sediments in Middle Waterway not meeting sediment quality objectives for indicator chemicals at present and 10 years after implementing feasible source control

Approximately 230,000 square yards of sediments in this problem area exhibited chemical concentrations exceeding cleanup objectives. Implementation of source control measures was not predicted to effect rapid natural recovery (Figure 8).

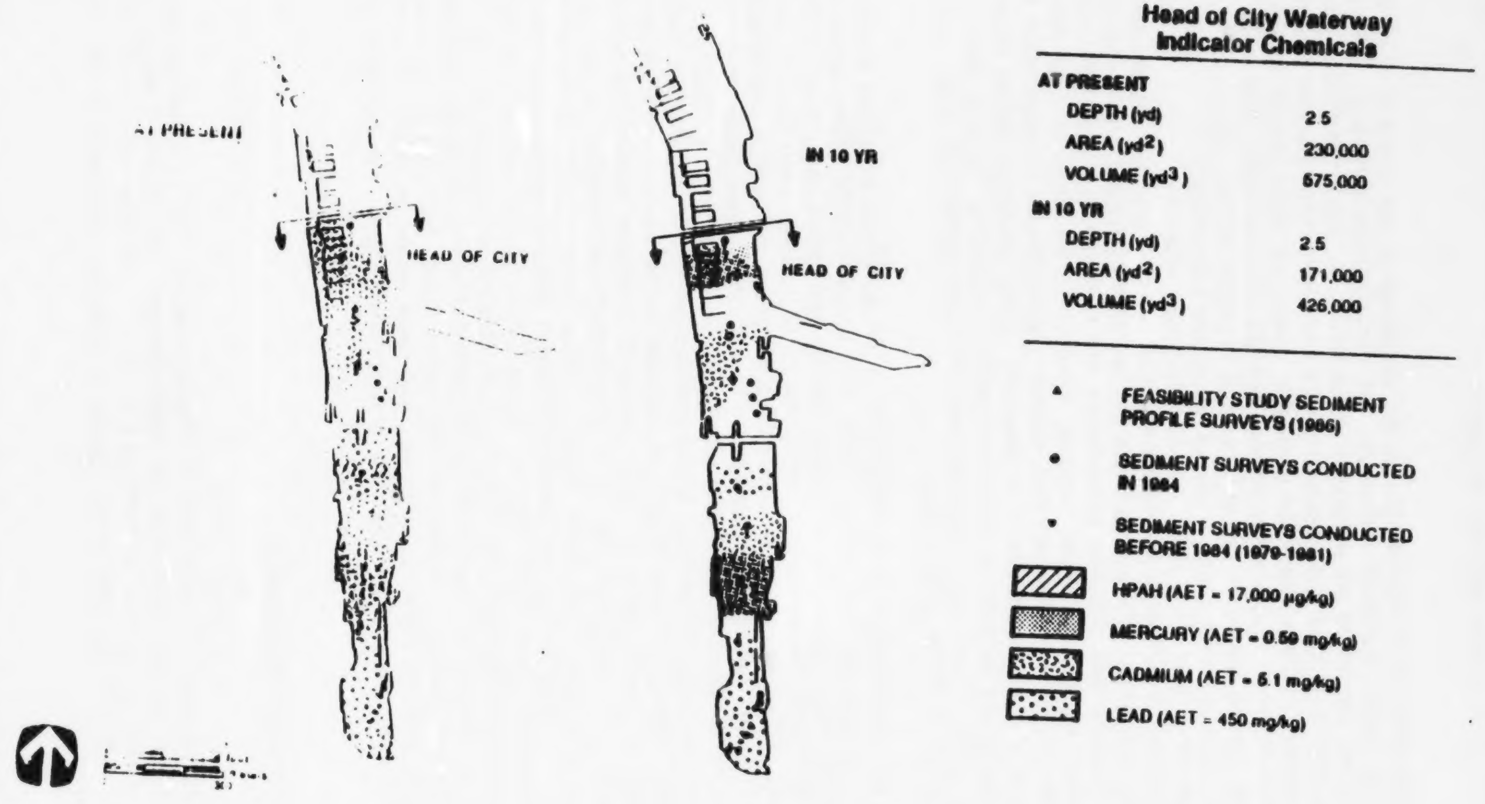
Source Characteristics—Contamination in the sediments at the Head of City Waterway is attributed to storm drains, maritime industries, and electroplating facilities. The locations of existing industries and businesses are presented in Appendix C. American Plating was identified as the most likely source of nickel contamination in a small area along the east shoreline of City Waterway, but appears to be a minor or negligible source of other metals in the waterway. Electroplating operations were conducted at the site between 1955 and 1986. The major mechanism transporting onsite contamination to the sediments is probably surface water runoff. Martinac Shipbuilding was associated with problem metals (especially copper and zinc) in sediments at the Head of City Waterway (Tetra Tech 1985, 1988a). Martinac, which has operated at the site since 1924, is involved primarily in design and construction of large commercial vessels, and some ship repair work is also conducted. Metals from the site are derived from sandblasting and painting operations. The Tacoma spur highway construction site is potentially associated with aromatic hydrocarbon contamination (i.e., PAHs, benzene, toluene) at the Head of City Waterway. A previous study (Hart Crowser 1984) reported extensive groundwater contamination at the site; however, the source of this contamination is unknown. Other potential sources of groundwater hydrocarbon contamination include an abandoned gasoline station at Puyallup and A streets, an equipment storage yard, a coal- and wood-powered electricity generating plant, and petroleum product and storage tanks (Tetra Tech 1988a).

Gradients in the concentration of contaminants in the sediments as well as known historical disposal practices indicate that the Nalley Valley and South Tacoma storm drains are major historical and possibly ongoing sources of organic matter and metals (e.g., lead) in the Head of City Waterway. The Nalley Valley storm drain serves approximately 2,800 acres to the south and east of the waterway. Commercial and industrial development in the basin is concentrated around the Interstate-5 and South Tacoma Way corridors. The South Tacoma storm drain serves 2,200 acres directly south of the head of the waterway. Land use in the basin is primarily residential, with commercial development concentrated in the northern portion of the drainage basin near the Interstate-5 corridor. These two storm drains are included in the ongoing pollution control effort underway by the city of Tacoma under the memorandum of agreement between the city of Tacoma, TPCHD, and Ecology. The Tacoma sewer utility is evaluating the feasibility of settling basins to control contaminant discharge from these drains. Storm Drain CI-230 serves approximately 530 acres consisting of a large part of the downtown Tacoma business district and a portion of the residential section west of the business district. Storm Drain CI-230, one of five major storm drains discharging to Commencement Bay waterways, is included in the ongoing pollution control effort implemented by the city of Tacoma under the memorandum of agreement between the city of Tacoma, TPCHD, and Ecology. Numerous other storm drains discharge to the Head of City Waterway. In general, problem chemicals associated with these drains are poorly characterized, and the relationships among activities in the basin and problem chemicals in the sediments are not well understood.

6.7 WHEELER-OSGOOD WATERWAY

Sediment Characteristics—The entire area of Wheeler-Osgood Waterway, approximately 22,000 square yards, contained problem chemicals in concentrations that exceed cleanup objectives. Implementation of source controls is not predicted to effect significant natural recovery within 10 years (Figure 9). HPAHs and zinc were selected as chemical indicators of the most severe sediment contamination.

Source Characteristics—Storm Drain CW-254 is the major source associated with problem chemicals in the sediments of Wheeler-Osgood Waterway. It is likely that problem chemical



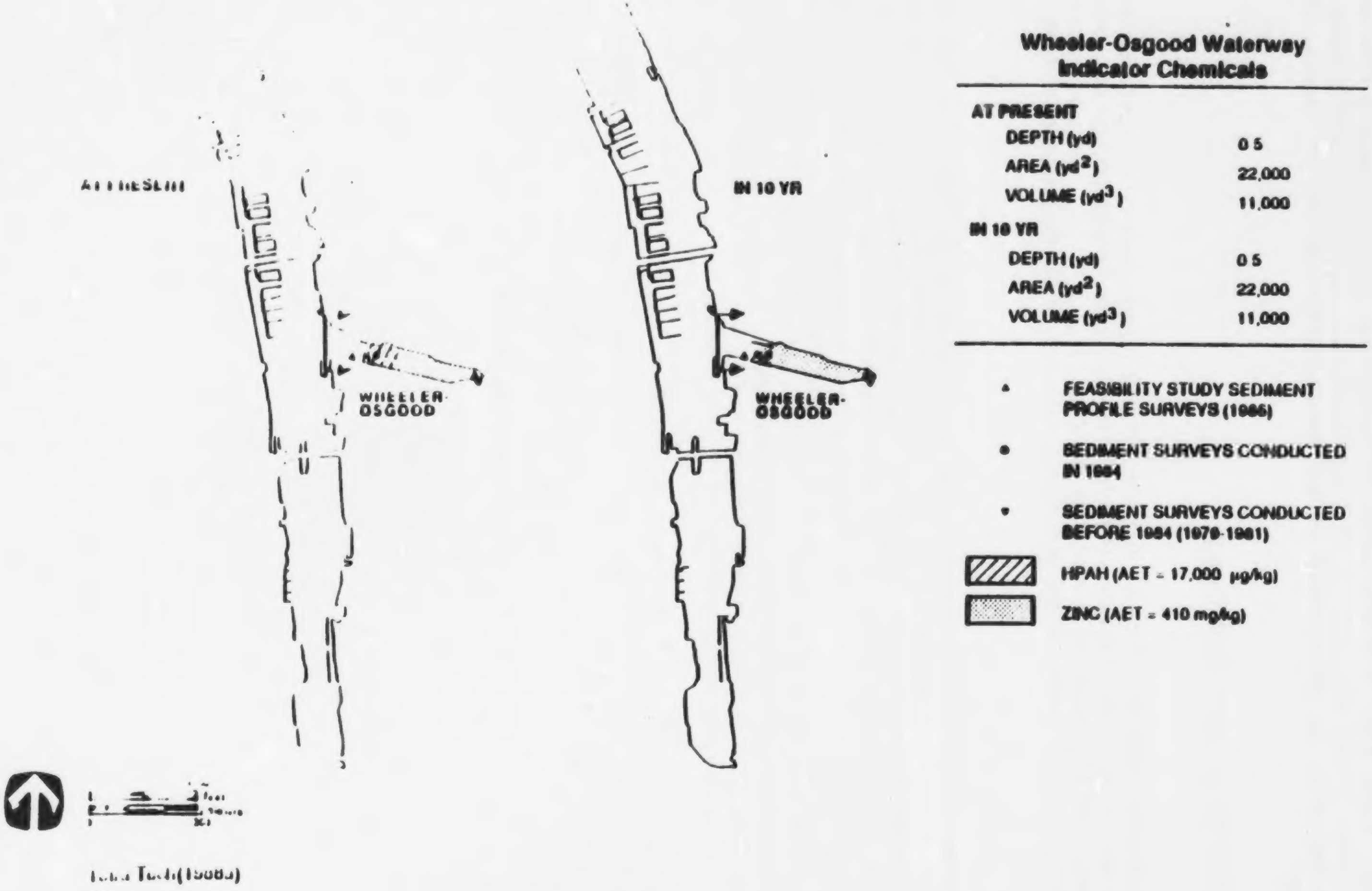
Head of City Waterway
Indicator Chemicals

AT PRESENT	
DEPTH (yd)	2.5
AREA (yd^2)	230,000
VOLUME (yd^3)	575,000
IN 10 YR	
DEPTH (yd)	2.5
AREA (yd^2)	171,000
VOLUME (yd^3)	426,000

- ▲ FEASIBILITY STUDY SEDIMENT PROFILE SURVEYS (1986)
- ● SEDIMENT SURVEYS CONDUCTED IN 1984
- ▼ SEDIMENT SURVEYS CONDUCTED BEFORE 1984 (1979-1981)
- ▨ HPAH (AET = 17,000 µg/kg)
- ▩ MERCURY (AET = 0.59 mg/kg)
- ▦ CADMIUM (AET = 5.1 mg/kg)
- ░ LEAD (AET = 450 mg/kg)

Tetra Tech (1988a)

Figure 8 Sediments at the Head of City Waterway not meeting sediment quality objectives for indicator chemicals at present and 10 years after implementing feasible source control


AT PRESENT
WHEELER-OSGOOD
IN 10 YR
WHEELER-OSGOOD
Feet
Meters
▲ FEASIBILITY STUDY SEDIMENT PROFILE SURVEYS (1986)
● SEDIMENT SURVEYS CONDUCTED IN 1984
• SEDIMENT SURVEYS CONDUCTED BEFORE 1984 (1979-1981)
▨ HPAH (AET = 17,000 µg/kg)
░ ZINC (AET = 410 mg/kg)

Wheeler-Osgood Waterway Indicator Chemicals

AT PRESENT	
DEPTH (yd)	0.5
AREA (yd^2)	22,000
VOLUME (yd^3)	11,000
IN 10 YR	
DEPTH (yd)	0.5
AREA (yd^2)	22,000
VOLUME (yd^3)	11,000

Tetra Tech (1988a)

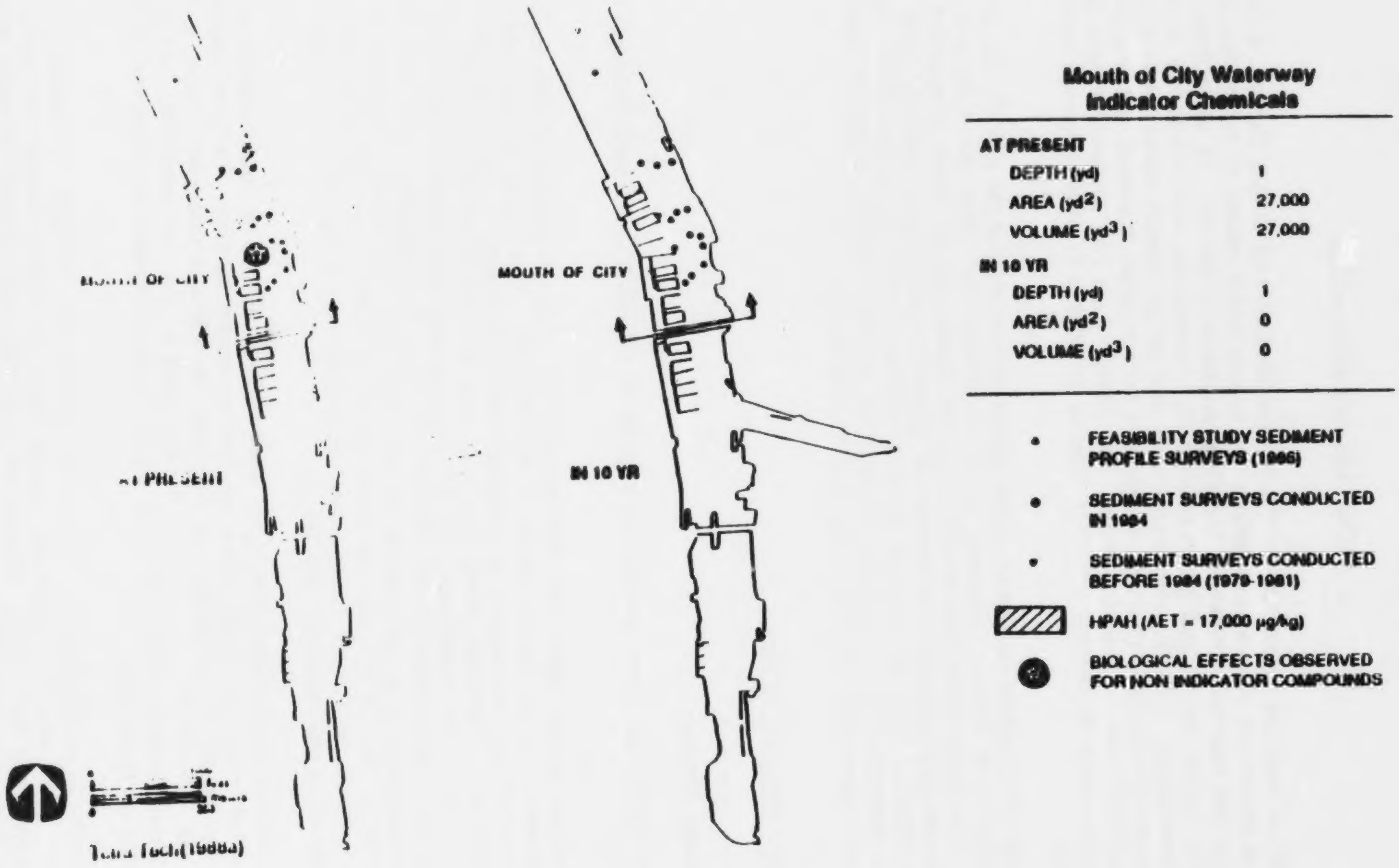
Figure 9. Sediments in Wheeler-Osgood Waterway not meeting sediment quality objectives for indicator chemicals at present and 10 years after implementing feasible source control

discharge was mainly historical. In the past, process wastes from Carstens Packing Company, a slaughterhouse and meat packing plant, were discharged directly to the waterway. Industrial facilities active in the drainage basin include Hygrade Food Products Corporation, Rainier Plywood Company, Kleen Blast, Northwest Container Corporation, Inc., and Chevron USA Incorporated. Storm Drain CW-254 is included in the ongoing pollution control effort implemented by the city of Tacoma under the memorandum of agreement between the city of Tacoma, TPCHD, and Ecology.

6.8 MOUTH OF CITY WATERWAY

Sediment Characteristics—An estimated 27,000 square yards of sediments at the Mouth of City Waterway exhibited chemical concentrations exceeding cleanup objectives. Implementation of source controls is predicted to eliminate this problem area entirely within 10 years (Figure 10). HPAHs and mercury were selected as chemical indicators of the most severe sediment contamination.

Source Characteristics—Contamination in sediments at the Mouth of City Waterway is attributed to petroleum storage facilities and unknown sources. The locations of existing industries and businesses are presented in Appendix C. The D Street petroleum facilities are an identified source of LPAHs in the Mouth of City Waterway, and they are the only identified source of problem chemicals in the waterway. Potential sources of other problem chemicals (e.g., mercury and HPAHs) in this portion of the waterway have not been verified (e.g., marina operations on the west shoreline). At the D Street petroleum facilities, spills and leakage of petroleum product have led to the groundwater contamination. Intermittent seepage of petroleum product has been observed along the City Waterway embankment since the early 1970s. An interceptor trench was installed in late 1987 to mitigate offsite transport of floating product.


MOUTH OF CITY
AT PRESENT
MOUTH OF CITY
IN 10 YR
FEASIBILITY STUDY SEDIMENT PROFILE SURVEYS (1986)
SEDIMENT SURVEYS CONDUCTED IN 1984
SEDIMENT SURVEYS CONDUCTED BEFORE 1984 (1979-1981)
HPAH (AET = 17,000 µg/kg)
BIOLOGICAL EFFECTS OBSERVED FOR NON INDICATOR COMPOUNDS

Mouth of City Waterway Indicator Chemicals

AT PRESENT	
DEPTH (yd)	1
AREA (yd^2)	27,000
VOLUME (yd^3)	27,000
IN 10 YR	
DEPTH (yd)	1
AREA (yd^2)	0
VOLUME (yd^3)	0

Tetra Tech (1988a)

Figure 10. Sediments at the Mouth of City Waterway not meeting sediment quality objectives for indicator chemicals at present and 10 years after implementing feasible source control

7. SUMMARY OF SITE RISKS

CERCLA response actions at the CB/NT site as described in this Record of Decision are intended to protect the marine environment and human health related to the marine environment from current and potential exposure to hazardous substances at the site. To assess these risks at the CB/NT site, human health and environmental risk assessments were conducted as part of the remedial investigation. The risk assessments were used in the remedial investigation to characterize the magnitude of risks associated with exposure to contaminated sediments and to prioritize areas within the CB/NT site for remedial action. The results of the risk assessments were also used in the feasibility study to develop sediment cleanup guidelines to protect human health and the environment.

Releases of hazardous substances to the marine environment at the CB/NT site have resulted in contamination of bottom sediments in the waterways and along the Ruston-Pt. Defiance Shoreline. The human health and environmental risk assessments are based on exposure of marine biota to contaminated sediment and exposure of humans to contaminated seafood. Risks to marine biota were estimated based on field and laboratory testing of sediments at the CB/NT site. Human health risks were estimated by assessing the potential for health impacts caused by consumption of local seafood containing contaminants also found in sediments.

7.1 HUMAN HEALTH RISKS

7.1.1 General Strategy

Human health risks from seafood consumption at the CB/NT site were evaluated in a two-phase process:

1. Baseline human health risks were estimated for chemicals detected in fish and crab tissue samples from the CB/NT site and a reference area. These analyses were used to identify chemicals that accumulated in organism tissues and resulted in significant risks to seafood consumers. Chemicals posing significant risks were identified by calculating carcinogenic risk levels or by comparison with EPA's acceptable daily intake (ADI) values. Risks of seafood consumption at the CB/NT site were also compared with risks of seafood consumption in an uncontaminated reference area, Carr Inlet. Chemicals posing risk levels at the CB/NT site that were similar to those at the reference area were not considered for further site cleanup evaluation (i.e., it was not considered feasible [illegible] cleanup to less than reference levels).

2. Chemicals posing significant risks were further evaluated for determination of sediment cleanup levels that would reduce site risks to acceptable levels. For these analyses, tissue concentrations of contaminants in fish from the reference area were selected as the target levels. Therefore, the objective of this phase of the risk assessment was to identify sediment quality levels that would result in the attainment of reference levels of fish tissue contamination.

The uptake of contaminants in CB/NT site seafood was evaluated by chemical analysis of three kinds of tissue samples: English sole muscle tissue (i.e., fillets), English sole livers, and crab muscle tissue (legs and body meat). English sole and crabs were selected for study because they live near the bottom in close association with contaminated bottom sediments. Although other species may have higher or lower contaminant levels in some parts of Puget Sound, English sole provide a representative measure of contaminant uptake by fishes and were present in large numbers in the CB/NT study area. Fish livers are probably eaten by only a very small number of anglers. However, the uptake and retention of contaminants in fish liver tissue is much higher than in muscle tissue. Thus, the use of combined muscle tissue and liver tissue data was also appropriate as an assessment of maximum potential exposures to a small part of the angling public.

7.1.2 Identification of Chemicals of Concern

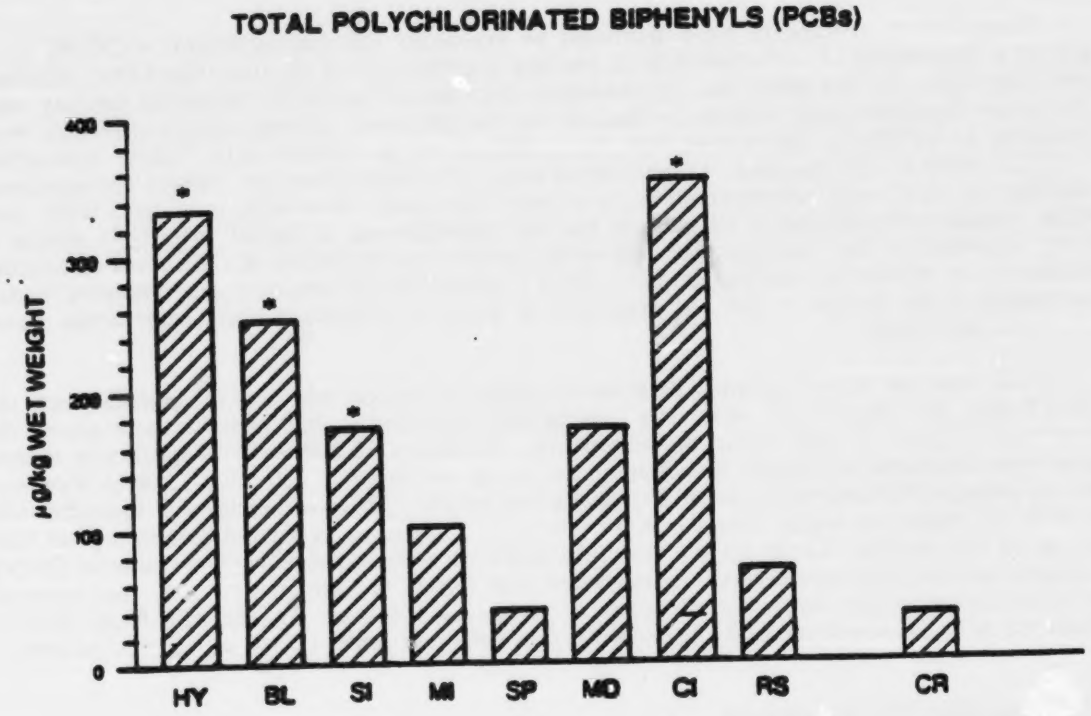
Contaminants of concern were identified by evaluating the concentrations in CB/NT biota and by a comparison of concentrations in seafood organisms from an uncontaminated reference area, Carr Inlet. Of the more than 100 chemicals analyzed for in CB/NT biological samples, only 16 organic chemicals were detected in English sole muscle tissue. Eleven organic chemicals were measured at sufficient frequencies and concentrations to be subjected to further evaluation: tetrachloroethene, ethylbenzene, hexachlorobenzene, 1,3-dichlorobenzene, hexachlorobutadiene, naphthalene, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, di-n-octyl phthalate, DDE, and PCBs. Metals were detected in all samples, but the concentrations in CB/NT biota were similar to levels measured in Carr Inlet samples. However, arsenic was identified as a chemical of concern because of its widespread contamination of CB/NT sediments and because it is a suspected human carcinogen, even though it was not measured in biota at statistically significant levels above reference conditions.

PCBs were the most frequently detected chemicals in English sole and crab samples from the CB/NT site. For English sole, there was considerable variability in PCB concentrations among the waterways (Figure 11) and within the waterways. Maximum PCB levels in English sole muscle tissue were measured in Hylebos Waterway (1,300 μg/kg wet weight). Sole from Hylebos Waterway had an average PCB concentration of 332 μg/kg wet weight. This average level is approximately an order of magnitude higher than the PCB concentration measured in English sole from Carr Inlet (36 μg/kg wet weight). Other organic chemicals displayed more localized contamination in CB/NT biological samples and were generally less elevated with respect to Carr Inlet samples. For example, hexachlorobenzene and hexachlorobutadiene were detected only in English sole from Hylebos Waterway at concentrations similar to the analytical detection limits (10-40 μg/kg wet weight).

7.1.3 Baseline Risk Assessment

The baseline risk assessment described in the CB/NT remedial investigation included a site-specific exposure assessment. The exposure assessment for consumption of fish and crabs from the CB/NT site included two elements: 1) estimating the exposed population, and 2) estimating the rate of fish and crab consumption. A survey conducted by TPCHD (Pierce et al. 1987) indicated that there are 4,070 shore and boat anglers in the Commencement Bay area. The average family size of the angler group was estimated at 3.74 persons. Thus, assuming that all members of a family eat the angler's catch, the total exposed population would be approximately 15,200 persons. Information on the average catch per trip and frequency of angling trips indicated that fish consumption rates vary considerably among the exposed population. Estimated consumption rates ranged from 1 pound/year (1.2 grams/day) to 1 pound/day (453 grams/day). Approximately 0.2 percent of the exposed population (i.e., 30 persons) were estimated to consume Commencement Bay fish at the very high rate of 1 pound/day (453 grams/day). Only about 7 percent of the exposed population consumed greater than 1 pound/month (15 grams/day). Therefore, about 93 percent of the exposed group consumed 1 pound/month or less. These two consumption rates were used as estimates of 1) the maximum potential exposure of a very small part of the population (1 pound/day), and 2) the maximum exposure rate experienced by a high percentage of the population (1 pound/month). In comparison, a more recent survey of seafood consumption throughout Puget Sound (Tetra Tech 1988b) indicates that the mean consumption rate is about 0.027 pounds/day (12.3 grams/day) and the 95th percentile consumption rate is about 0.21 pounds/day (95 grams/day).

Health risks were estimated for consumers of CB/NT fish and shellfish on a chemical-by-chemical basis for carcinogens (e.g., PCBs and arsenic) and noncarcinogens (e.g., copper and mercury). For carcinogens, risks were calculated by multiplying EPA's cancer potency factor for



Tetra Tech (1985)

* AREAS STATISTICALLY DIFFERENT FROM REFERENCE (P<0.05)

HY = Hylebos Waterway
BL = Blair Waterway
SI = Sitcum Waterway
MI = Milwaukee Waterway
SP = St. Paul Waterway
MD = Middle Waterway
CI = City Waterway
RS = Ruston-Pt. Defiance Shoreline
CR = Carr Inlet

Figure 11. Concentrations of total PCBs in English sole muscle tissue

each chemical by the estimated intake of that chemical. The resultant individual lifetime cancer risks are expressed in scientific notation (e.g., 1×10^{-6}). An estimated risk of 1×10^{-6} indicates that, as a plausible upper bound, an individual has a one in one million chance of developing cancer as a result of site-related exposure to the carcinogen over a 70-year lifetime (under the specific exposure conditions assumed at the site). EPA generally considers excess risks in the range of 10^{-4} to 10^{-7} as acceptable; however, the 10^{-6} level is used as a point of departure for setting cleanup levels under CERCLA response actions when promulgated criteria are not available. Potential concern for noncarcinogens was evaluated by comparing the estimated lifetime intake rate of a chemical with EPA's ADI value for that chemical.

The first step in the risk assessment as described in the CB/NT remedial investigation was to calculate the individual lifetime risks for ingestion of carcinogens in fish muscle tissue. For the purposes of this risk assessment, the average concentration of each chemical in English sole from the study area was used to calculate exposure. Based on these calculations, only six chemicals were predicted to result in a risk $>10^{-6}$ at the maximum fish consumption rate of 1 pound/day (Table 3) and only PCBs and arsenic had predicted risk levels greater than 1×10^{-4}. At a fish consumption rate of 1 pound/month, only PCBs and arsenic would exceed the 10^{-6} risk level.

For PCBs and arsenic, the risks of consuming crabs from the CB/NT site were approximately the same as the risks of eating fish. All other carcinogens measured in crab muscle resulted in predicted risks less than 10^{-6} at the maximum consumption rate of 1 pound/day. No site-specific data were available for crab consumption rates. Therefore, the consumption rates for fish were used in the crab risk assessment.

Consumption of PCBs in fish livers could result in a relatively high individual lifetime risk of 2×10^{-2} for individuals in the maximum fish consumption group (Table 4). The actual consumption of fish livers is unknown; therefore, this estimate was based on the assumption that the amount of fish liver consumed was proportional to the liver weight relative to total fish weight (i.e., 0.12).

For noncarcinogens, three metals (antimony, lead, and mercury) were present in fish muscle tissue in concentrations that would exceed the ADI values at the very high consumption rate of 1 pound/day. However, the ADI values would also be exceeded for fish from Carr Inlet at the 1 pound/day consumption rate. Limiting consumption of fish to 0.5 pound/day would result in exposure below the ADI values for all three metals. Bioaccumulation data indicated that sediment contamination by metals in Commencement Bay was not resulting in significantly increased tissue levels for metals. Therefore, risks of noncarcinogens in fish tissue was not evaluated further in estimating sediment cleanup levels. Moreover, source control and sediment remediation or recovery throughout the site is expected to reduce even this small excess risk of metals to insignificant levels.

The baseline risk assessments conducted for the CB/NT site indicated that the most significant human health risks are associated with elevated concentrations of PCBs in the tissues of resident seafood. Arsenic was not subjected to further evaluation relative to human health because of its lower risk level and because arsenic concentrations in CB/NT fish are similar to concentrations in fish from the reference area.

7.2.4 Relationship to Sediment Quality Objectives

The next step in the risk assessment was to evaluate the relationship between sediment contamination and fish tissue contamination so that a PCB cleanup level could be evaluated for its effectiveness in reducing risks to seafood consumers. Details of the quantitative methods used to estimate sediment cleanup levels to protect human health are provided in Tetra Tech (1988a). The calculation of a sediment cleanup level for PCBs to protect human health was established in relation to reference conditions, assuming that more stringent cleanup levels would be infeasible. The calculation therefore involved three key determinations and assumptions:

TABLE 3. ESTIMATED INDIVIDUAL LIFETIME RISKS FROM EATING FISH MUSCLE TISSUE CONTAINING ORGANIC COMPOUNDS

Chemical	Average Concentration (wet weight)	Consumption Rate	
		1 pound/day	1 pound/month
PCBs	210 μg/kg	6×10^{-3}	2×10^{-4}
Arsenic	4.1 mg/kg	4×10^{-4}	1×10^{-5}
Hexachlorobenzene	11 μg/mg	1×10^{-4}	4×10^{-6}
Hexachlorobutadiene	40 μg/kg	2×10^{-5}	7×10^{-7}
Bis(2-ethylhexyl)phthalate	194 μg/mg	2×10^{-5}	6×10^{-7}
Tetrachloroethene	66 μg/kg	1×10^{-5}	5×10^{-7}

TABLE 4. PROJECTED LIFETIME CANCER RISKS FOR PCBs AND ARSENIC

Consumption Frequency (1 pound)	Fish Intake (grams/day)	Exposure (mg/kg/day)	Individual Risk	Exposed Population
PCBs				
Daily	453.0	1.36×10^{-3}	5.90×10^{-3}	30
Weekly	64.7	1.94×10^{-4}	8.42×10^{-4}	1,005
Monthly	15.1	4.53×10^{-5}	1.97×10^{-4}	1,735
Bimonthly	7.4	2.22×10^{-5}	9.63×10^{-5}	1,111
Twice/year	2.5	7.50×10^{-6}	3.26×10^{-5}	2,618
Yearly	1.2	3.60×10^{-6}	1.56×10^{-5}	8,721
Total				15,220
Arsenic				
Daily	453.0	3.16×10^{-5}	4.42×10^{-4}	30
Weekly	64.7	4.51×10^{-6}	6.31×10^{-5}	1,005
Monthly	15.1	1.05×10^{-6}	1.47×10^{-5}	1,735
Bimonthly	7.4	5.16×10^{-7}	7.22×10^{-6}	1,111
Twice/year	2.5	1.74×10^{-7}	2.44×10^{-6}	2,618
Yearly	1.2	8.37×10^{-8}	1.17×10^{-6}	8,721
Total				15,220

- **Fish Tissue Concentration Objective:** The average PCB level measured in English sole from the Carr Inlet reference area was selected as the target tissue concentration following sediment cleanup at the CB/NT site. This PCB level in fish tissue (36 μg/kg) results in an individual lifetime risk in the 10^{-5} range for a seafood consumption rate of 1 pound/month.

- **Reference Sediment Concentrations:** Applicable sediment remedial technologies (e.g., removal or capping) were assumed to result in the attainment of background sediment PCB levels (20 μg/kg) at the actual cleanup site by either dredging and exposing clean sediments, or by capping with clean material.

- **Method of Quantitative Relationship:** The equilibrium partitioning method was selected to determine quantitative relationships between sediment contamination and fish tissue contamination. This method assumes that a thermodynamic equilibrium exists between contaminants in sediments and contaminants in fish tissue, and that the relationship can be described quantitatively based on the distribution of a pollutant as a function of fish lipids and sediment organic carbon. Because of fish movement and the time required to reach equilibrium, it is also assumed that the equilibrium fish tissue concentrations are representative of the average sediment PCB levels in a waterway.

Application of the selected equilibrium partitioning equation to the CB/NT data indicated that a sediment PCB level of 30 μg/kg would result in attainment of a fish tissue concentration of 36 μg/kg wet weight. Based on this calculation, alternative sediment cleanup objectives ranging from 50 to 1,000 μg/kg were evaluated for PCBs according to the following iterative method with the intent of achieving an average fish tissue concentration for PCBs similar to reference conditions:

1. An average reference sediment PCB concentration of 20 μg/kg was substituted for all measured sediment concentrations exceeding a particular cleanup objective (e.g., 1,000 μg/kg)
2. An overall post-cleanup sediment concentration was calculated as the geometric mean of the post-cleanup data set following substitution of all values greater than a particular cleanup objective (e.g., 1,000 μg/kg) with values of 20 μg/kg
3. The mean residual sediment concentration was used to calculate the predicted mean fish tissue concentration using the equilibrium partitioning model
4. The mean predicted fish tissue concentration was compared to the fish tissue concentration objective (i.e., 36 μg/kg).

Compilation and evaluation of these results indicated that a PCB sediment cleanup level of 150 μg/kg would result in an average post-cleanup sediment concentration of 30 μg/kg for Hylebos Waterway or for the CB/NT site in general. This cleanup level would also result in attainment of fish PCB levels similar to those in Puget Sound reference areas. The health risks of seafood consumption from remediated waterways would be about 4×10^{-5} for a seafood consumption rate of 2.3 g/day, and therefore be comparable to the risks in reference areas.

[illegible].2 ENVIRONMENTAL RISK ASSESSMENT

[illegible].2.1 General Strategy

The CB/NT investigations have had a major focus on environmental risks because of the adverse biological effects documented in past studies of the area and because of the high potential for exposure of marine biota to sediment-associated contaminants. The historical data for the area indicated that sediments were contaminated by a wide variety of chemicals, with contamination patterns and potential sources differing considerably among the waterways. Because of this site complexity and the lack of available regulatory standards or guidelines for establishing cleanup criteria for contaminated sediments, a decision-making approach was developed specifically for the CB/NT investigations that included characterization of sediment problems, development of sediment quality objectives, identification of problem chemicals, and definition of problem areas requiring sediment remediation.

The environmental risk assessment framework developed for the remedial investigation incorporates a preponderance-of-evidence approach that is implemented in a stepwise manner to identify and rank toxic problem areas and problem chemicals.

Ideally, sediment quality objectives and sediment management decisions would be supported by definitive cause and effect information relating specific chemicals to biological effects in various aquatic organisms and to quantifiable human health risks. However, very little information of this type is currently available, and it is unlikely that additional information will be available in the near future. In the interest of protecting human health and the environment, regulatory agencies must proceed with sediment management decisions based on the best information available.

The application of the ecological risk assessment approach for the CB/NT site was based on three important premises. First, it was assumed that the development of cleanup objectives to define problem sediments and chemicals would require the analysis of site-specific data collected as part of the remedial investigation. Second, it was assumed that no single chemical or biological indicator could be used to define problem sediments. Therefore, the risk assessment would be based on several independent measures of contamination and biological effects. Third, it was assumed that adverse biological effects are linked to sediment contamination and that these links could be characterized empirically. Thus, a preponderance of field and laboratory evidence linking contaminant concentrations with adverse biological effects could be used to establish an empirical relationship despite the lack of information establishing cause and effect relationships.

The preponderance-of-evidence approach required the selection of several measurements to serve as indicators of contamination and biological effects at the CB/NT site. The following five groups of indicator variables were selected:

- **Sediment contamination**—Concentrations of chemicals and chemical groups
- **Bioaccumulation**—Contaminant concentrations in English sole
- **Sediment toxicity**—Acute mortality of amphipods and abnormalities in oyster larvae
- **Benthic infauna**—Abundances of major taxa
- **Fish histopathology**—Prevalences of liver lesions in English sole.

7.2.2 Identification of Problem Chemicals

The CB/NT investigations indicated that area sediments were contaminated by numerous inorganic and organic chemicals at levels substantially above Puget Sound reference conditions. Because of the extensive list of sediment contaminants, a procedure was developed to identify and rank problem chemicals so that source and cleanup evaluations could be focused on the chemicals posing the greatest environmental or public health risk. The overall identification of problem chemicals involved a three-step process. In the first step, historical data for the site were reviewed to select a suite of chemicals to be analyzed in the remedial investigation. This suite of chemicals included EPA priority pollutants, many EPA Hazardous Substance List compounds, and several organic compounds that are not on the EPA lists. Following the remedial investigation sampling, a group of chemicals of concern was then identified from the overall list of analytes. Chemicals of concern were defined as chemicals with concentrations exceeding all Puget Sound reference conditions. These chemicals are not necessarily considered problem chemicals because sediments may be contaminated above reference conditions without exhibiting toxicity or biological effects. In the final step, the chemicals of concern were evaluated for their relationship to biological effects. The objective of this step was to define problem chemicals so that source identification and remedial alternatives analyses could be focused on a limited suite of chemicals that apparently posed the greatest environmental risk. Problem chemicals were defined as those chemicals whose concentration exceeded the apparent effects threshold (AET) in the problem area. Because the AET was defined as the contaminant concentration above which toxicity or benthic effects are always observed, chemicals present in concentrations above this threshold are likely contributors to observed biological effects.

Problem chemicals were further ranked according to their association with toxicity or biological effects. Based on this approach, three priorities of problem chemicals were given for each problem area. The highest priority (Priority 1) chemicals were defined as those present above an AET in a problem area and that also exhibited a concentration gradient corresponding to observed changes in sediment toxicity or benthic effects. For example, strong linear relationships were found between sediment toxicity and PCB concentrations in Hylebos Waterway and between sediment toxicity and 4-methylphenol concentrations in St. Paul Waterway. Other contaminants were found at levels above AET in these problem areas, but none displayed these strong relationships with sediment toxicity. Therefore, these two chemicals were given the highest priority for source evaluation and cleanup actions because of their demonstrated correspondence with observed toxicity. Priority 1 chemicals included:

- Mercury, lead, zinc, and arsenic
- PCBs, 4-methylphenol, HPAHs, and LPAHs.

Priority 2 chemicals were defined as those that occurred above the AET in the problem area but showed no particular relationship with effects gradients (or insufficient data were available to evaluate their correspondence with gradients). Chemicals with concentrations above the AET only at nonbiological stations were therefore placed no higher than Priority 2 because of the lack of biological data. These chemicals included:

- Cadmium, nickel, and antimony
- Hexachlorobutadiene, chlorinated benzenes, chlorinated ethenes, phenol, 2-methylphenol, N-nitrosodiphenylamine, dibenzofuran, selected phthalate esters, and selected tentatively identified compounds (e.g., 2-methoxyphenol).

Finally, chemicals with concentrations above AET at only one station within the problem area were assigned Priority 3. Problem chemicals for problem areas that were small hotspots of sediment contamination usually fell into this category.

7.2.3 Identification of Problem Areas

A series of simple indices was developed for each of the five indicators for contamination, toxicity, and biological effects to enable ranking of areas based on the relative magnitude of observed contamination and effects. These indices were defined in the general form of a ratio between the value of a variable at the CB/NT site and the value of the variable at a reference site. The indicator ratios were structured so that the value of the index increased as the deviation from reference conditions increased. Thus, each ratio was termed an elevation above reference (EAR) index. The environmental contamination and effects indicators (EAR) were used to compare the entire CB/NT study area and for individual waterways with individual sampling stations or groups of stations (i.e., waterway segments) as the study units.

Chemical contamination of CB/NT sediments was very uneven. Some chemicals (e.g., arsenic, copper, 4-methylphenol, and benzo(a)pyrene) were measured at concentrations exceeding 1,000 times reference levels. Biological effects were also highly varied among study areas. For example, amphipod mortality reached 95-100 percent at two sites, while mortalities in several other areas were indistinguishable from reference levels (7-25 percent). Similarly, analyses of benthic infauna indicated severe stress, as evidenced by very low abundances, at some sampling stations and apparently normal benthic assemblages at other sites. English sole were very abundant in the

CB/NT waterways. However, 25-40 percent of the sole from several waterways had one or more serious liver abnormalities, including cancers and precancerous conditions. Only about 7 percent of reference area sole had these liver abnormalities.

Toxic problem areas were defined as those areas with sufficient evidence of contamination and biological effects to warrant the evaluation of contaminant sources and possible remedial alternatives. The identification of these problem areas required the specification of criteria incorporating combinations of contamination and effects indices that would result in problem area identification. It was assumed that an area or segment would require no action unless at least one of the indicators of contamination, toxicity, or biological effects was significantly elevated above reference conditions. Final prioritization of problem areas for remedial action was determined based on three additional criteria:

- Environmental significance (i.e., the number and magnitude of significant contaminant and effects indices)
- Spatial extent of contamination
- Confidence in source identification.

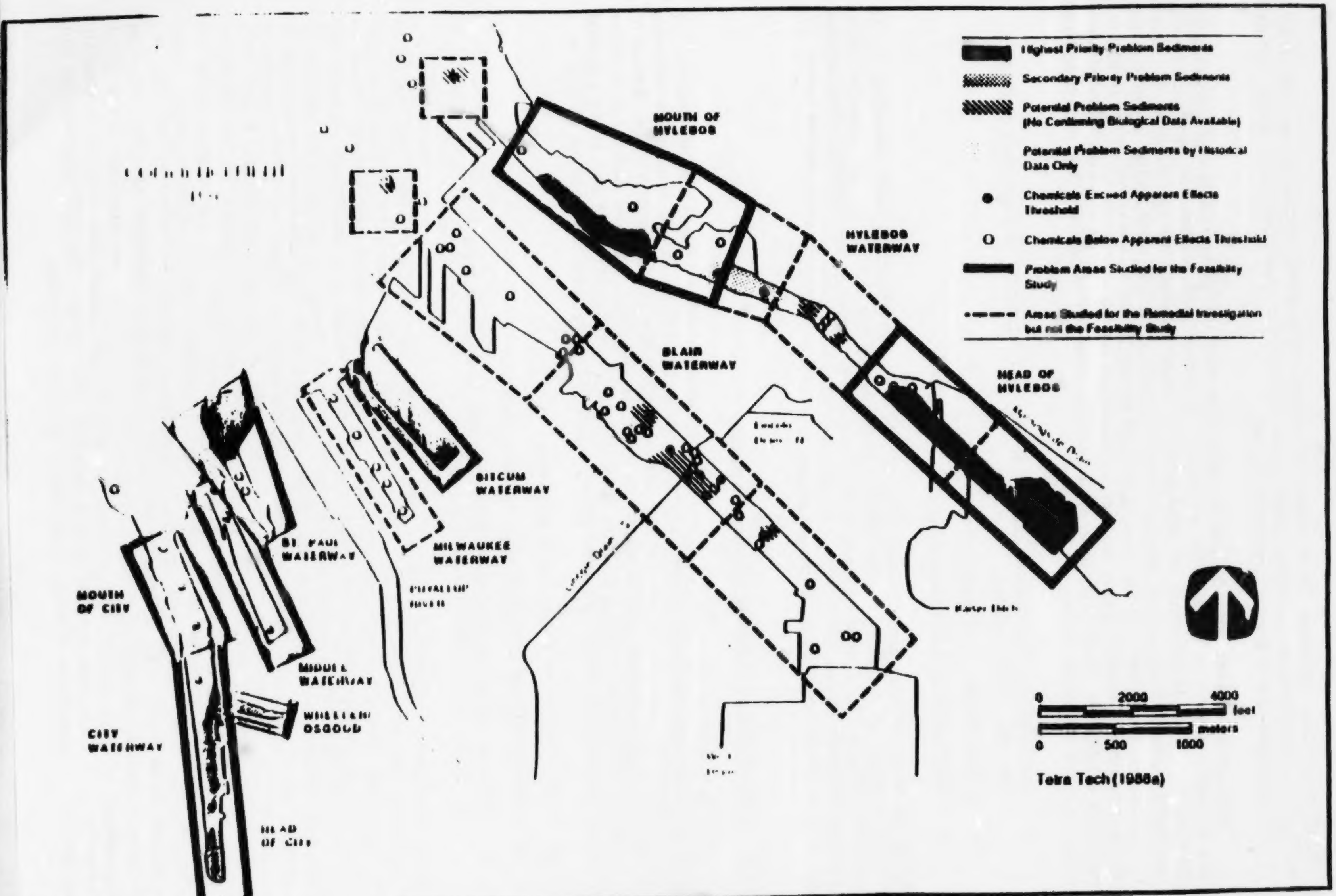
Based on these criteria, nine discrete areas of sediment contamination were identified in the feasibility study as priority problem areas warranting further evaluation and response under Superfund (Figure 12). Overall, these priority problem areas displayed the following characteristics: multiple biological effects and significantly elevated chemicals, relatively large spatial extent, and one or more identified sources of contamination.

7.2.4 Relationship to Sediment Quality Objectives

The next step in the remedial investigation/feasibility study process was to evaluate the relationship between sediment contamination and biological effects so that measurable sediment quality objectives could be defined for both sediment chemistry and sediment biology. Details of the decision-making process used to select a method for evaluating sediment toxicity as it relates to biological effects are provided in Tetra Tech (1988a) and PTI (1989). As part of the remedial investigation/feasibility study, sediment quality objectives were required that could be used to:

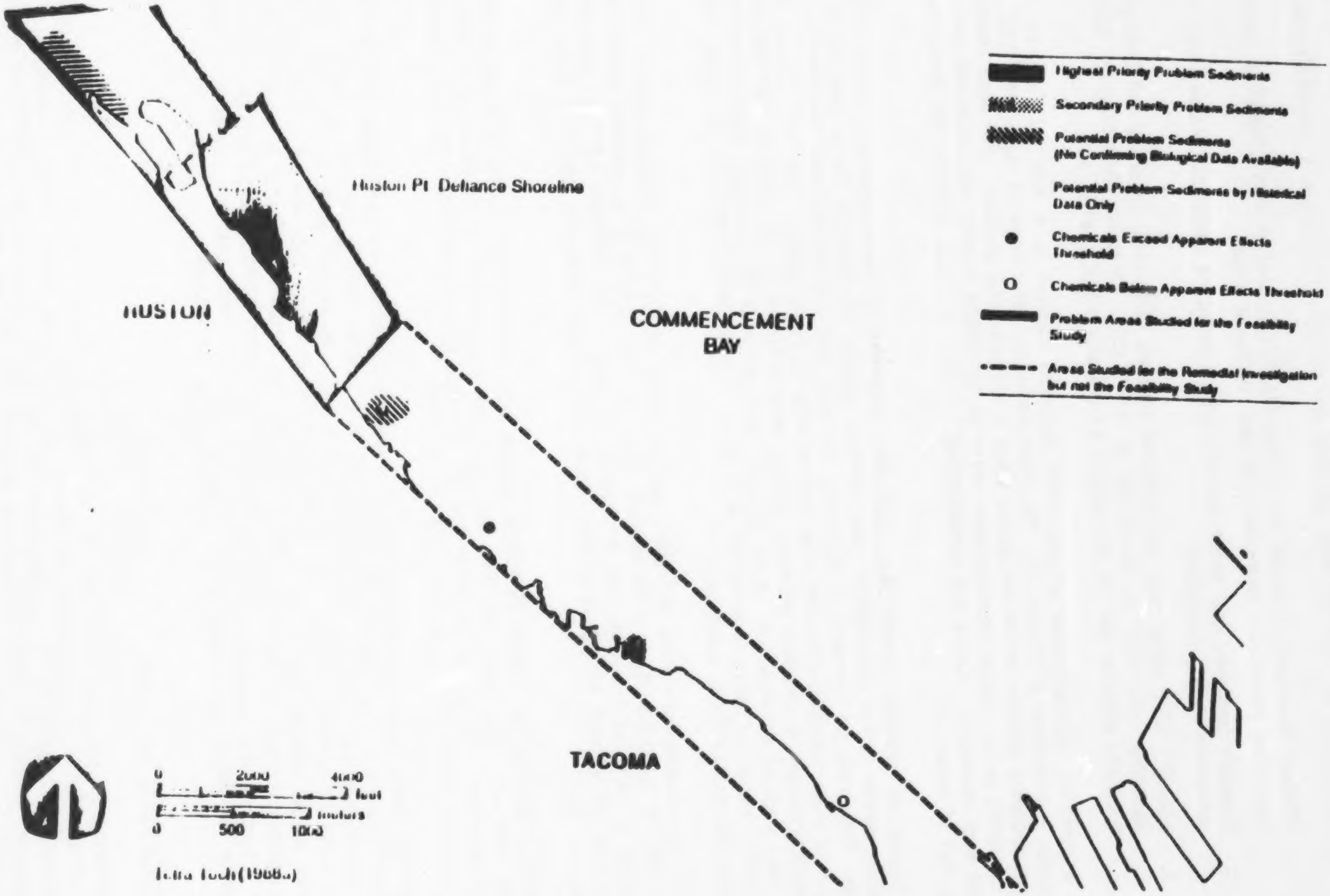
- Identify problem chemicals in sediments
- Identify sources associated with problem chemicals
- Establish spatial designation of problem areas, especially in areas where site-specific biological testing results were not available.

Several approaches to sediment quality objectives based on laboratory, field, and theoretical relationships were evaluated for application to the CB/NT site. Approaches evaluated included reference areas, screening level concentrations, AET, and equilibrium partitioning. Based on consideration of management and technical criteria and on results of a verification exercise with field-collected data, the AET approach was selected and confirmed as the preferred method for developing sediment quality values in the CB/NT area. An AET is the sediment concentration of a chemical above which statistically significant ($P \leq 0.05$) biological effects are always observed in the data set used to generate AET values. In other words, if any chemical exceeds its AET for a particular biological indicator, then an adverse biological effect is predicted for that indicator. Alternatively, if all chemical concentrations are below their AET, then no adverse effects are predicted. The AET approach can be used to provide chemical-specific sediment quality values for the greatest number and widest range of chemicals of concern in Commencement Bay and throughout Puget Sound. AET can also be developed for a range of biological indicators, including laboratory-controlled bioassays and *in situ* benthic infaunal analyses. An additional advantage of using existing AET for the CB/NT site is that the remedial investigation data constitute a relatively large proportion of the total data set used to generate AET values. The AET approach has also been selected for application in other Puget Sound regulatory programs.


Highest Priority Problem Sediments
Secondary Priority Problem Sediments
Potential Problem Sediments (No Confirming Biological Data Available)
Potential Problem Sediments by Historical Data Only
Chemicals Exceed Apparent Effects Threshold
Chemicals Below Apparent Effects Threshold
Problem Areas Studied for the Feasibility Study
Areas Studied for the Remedial Investigation but not the Feasibility Study
MOUTH OF HYLEBOS
HYLEBOS WATERWAY
HEAD OF HYLEBOS
BLAIR WATERWAY
SITCUM WATERWAY
MILWAUKEE WATERWAY
PUYALLUP RIVER
ST. PAUL WATERWAY
MOUTH OF CITY
MIDDLE WATERWAY
WHEELER-OSGOOD
CITY WATERWAY
HEAD OF CITY
0
2000
4000
feet
0
500
1000
meters

Tetra Tech (1988a)

Figure 12. Relationship between problem areas identified during the remedial investigation and those studied for the feasibility study


Highest Priority Problem Sediments
Secondary Priority Problem Sediments
Potential Problem Sediments (No Confirming Biological Data Available)
Potential Problem Sediments by Historical Data Only
● Chemicals Exceed Apparent Effects Threshold
○ Chemicals Below Apparent Effects Threshold
Problem Areas Studied for the Feasibility Study
Areas Studied for the Remedial Investigation but not the Feasibility Study
Ruston Pt. Defiance Shoreline
RUSTON
COMMENCEMENT BAY
TACOMA
0
2000
4000
feet
meters
0
500
1000

Tetra Tech (1988a)

Figure 12 (Continued)

The calculation of AET for each chemical and biological indicator is straightforward:

1. Collect "matched" chemical and biological effects data at many sampling stations, including potentially impacted sites and reference areas.
2. Identify impacted and nonimpacted stations based on statistical comparisons with reference station conditions.
3. Identify AET using only nonimpacted stations. For each chemical and biological indicator, the AET is identified as the highest detected concentration among sediment samples that do not exhibit statistically significant effects.

A pictorial representation of the AET approach applied to a data set for two example chemicals is presented in Figure 13. For each chemical, the ranges of significant and nonsignificant sediment toxicity results are shown along a concentration gradient. For each chemical, the AET is shown as the highest concentration where no significant toxicity was measured (i.e., the top bar for each chemical). Above this concentration for each chemical, toxicity was always measured (solid part of lower bar).

During the remedial investigation, AET were generated for three biological effects (amphipod mortality, oyster larvae abnormality, and benthic infauna abundances) for a data set of 50-60 stations. Following the remedial investigation, the AET data set was expanded considerably by the addition of other synoptic data sets from various areas in Puget Sound. The AET data set used in the feasibility study to establish sediment cleanup goals consisted of 334 stations, and included data from other areas of Puget Sound. A list of AET used to define the sediment quality objectives for the CB/NT feasibility study is provided in Table 5. These values represent the lowest AET for the three biological effects indicators.

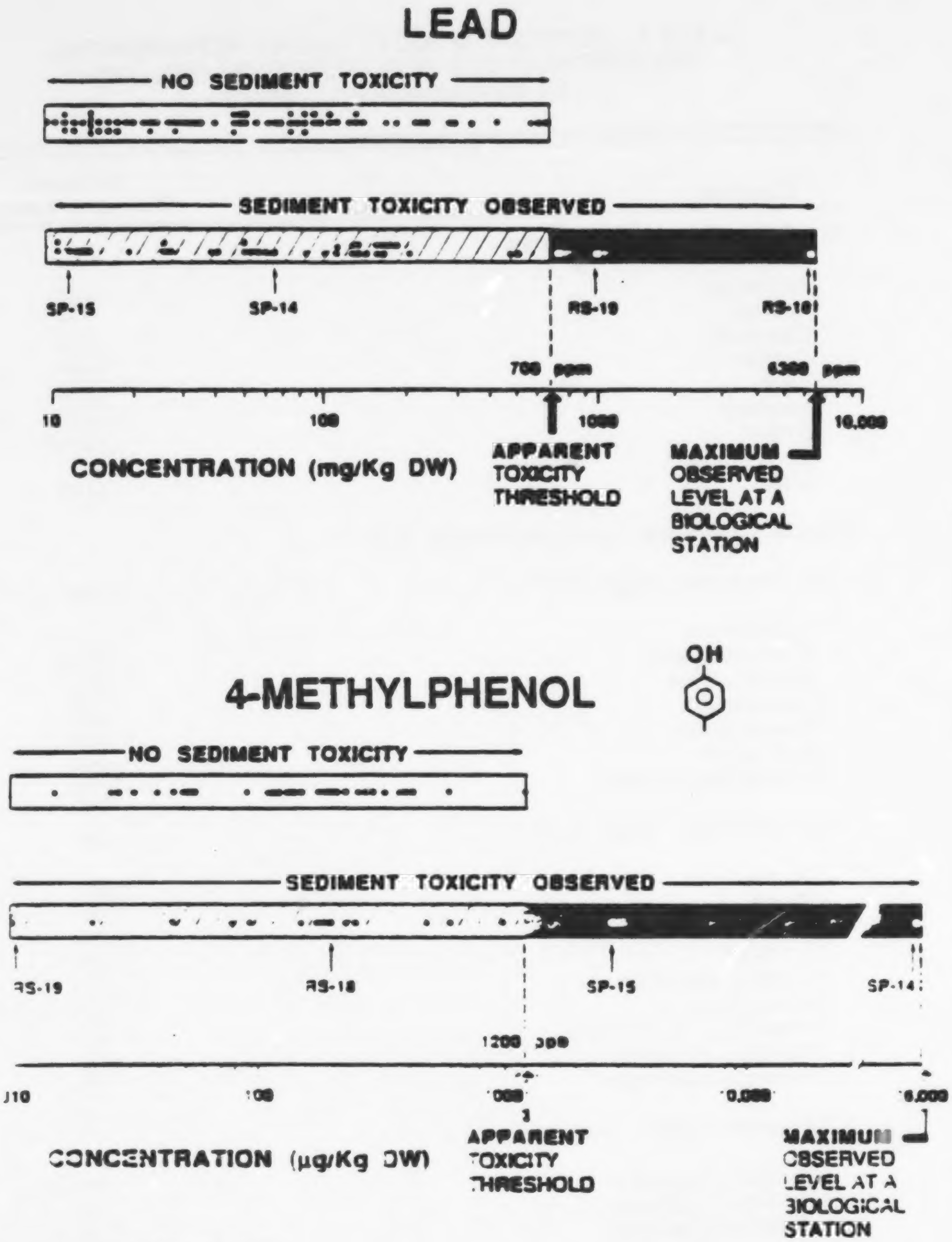
The three biological effects indicators used to define AET-derived sediment quality objectives for the CB/NT feasibility study were selected based on their sensitivity to sediment contamination, availability of standard protocols, and ecological relevance. The resultant AET are applicable to a wide range of relevant biological effects, thereby providing protection against a wide range of impacts.

Benthic infauna are valuable indicators because they live in direct contact with the sediments, they are relatively stationary, and they are important components of estuarine ecosystems. If sediment-associated impacts are not present in the infauna, then it is unlikely that such impacts are present in other biotic groups such as fishes or plankton.

The test species used in amphipod toxicity tests (*Rhepoxynius abronius*) resides in Puget Sound and is a member of a crustacean group that forms an important part of the diet of many estuarine fishes. Amphipods are generally pollution sensitive, and species such as *R. abronius* have a high pollutant exposure potential because they burrow into the sediment and feed on sediment material. The oyster larvae bioassay uses a test species (*Crassostrea gigas*) that resides in Puget Sound and supports commercial and recreational fisheries. The life stages tested (embryo and larva) are very sensitive stages of the organism's life cycle. The primary endpoint is a sublethal change in development that has a high potential for effecting larval recruitment.

7.3 MITIGATING FACTORS

Assessment of chemical contamination and biological effects at the CB/NT site indicated the presence of significant environmental and human health risks in several areas. Evaluation of the nature, extent, and magnitude of contamination and biological effects at the CB/NT site indicates that the primary mitigation factor influencing sediment remediation decisions is natural recovery of the sediment environment.



U - Undetected at detection limit shown

Figure 13. The AET approach applied to sediments tested for lead and 4-methylphenol concentrations and toxicity response during bioassays

TABLE 5. SEDIMENT QUALITY VALUES REPRESENTING THE SEDIMENT CLEANUP OBJECTIVES RELATED TO ENVIRONMENTAL RISKS

Chemical	Sediment Cleanup Objective[a]
Metals (mg/kg dry weight; ppm)	
Antimony	150^{B}
Arsenic	57^{B}
Cadmium	5.1^{B}
Copper	390^{L}
Lead	450^{B}
Mercury	0.59^{L}
Nickel	$>140^{A,B}$
Silver	6.1^{A}
Zinc	410^{B}
Organic Compounds (µg/kg dry weight; ppb)	
Low molecular weight PAH	$5{,}200^{L}$
Naphthalene	$2{,}100^{L}$
Acenaphthylene	$1{,}300^{A,B}$
Acenaphthene	500^{L}
Fluorene	540^{L}
Phenanthrene	$1{,}500^{L}$
Anthracene	960^{L}
2-Methylnaphthalene	670^{L}
High molecular weight PAH	$17{,}000^{L}$
Fluoranthene	$2{,}500^{L}$
Pyrene	$3{,}300^{L}$
Benz(a)anthracene	$1{,}600^{L}$
Chrysene	$2{,}800^{L}$
Benzofluoranthenes	$3{,}600^{L}$
Benzo(a)pyrene	$1{,}600^{L}$
Indeno(1,2,3-c,d)pyrene	690^{L}
Dibenzo(a,h)anthracene	230^{L}
Benzo(g,h,i)perylene	720^{L}
Chlorinated organic compounds	
1,3-Dichlorobenzene	$170^{A,L,B}$
1,4-Dichlorobenzene	110^{B}
1,2-Dichlorobenzene	$50^{L,B}$
1,2,4-Trichlorobenzene	51^{A}
Hexachlorobenzene (HCB)	22^{B}
Total PCBs	$1{,}000^{B,*}$

TABLE 5. Continued

Chemical	Sediment Cleanup Objective[a]
Phthalates	
Dimethyl phthalate	160^{L}
Diethyl phthalate	200^{B}
Di-n-buytl phthalate	$1,400^{A,L}$
Butyl benzyl phthalate	$900^{A,B}$
Bis(2-ethylhexyl)phthalate	$1,300^{B}$
Di-n-octyl phthalate	$6,200^{B}$
Phenols	
Phenol	420^{L}
2-Methylphenol	$63^{A,L}$
4-Methylphenol	670^{L}
2,4-Dimethylphenol	29^{L}
Pentachlorophenol	360^{A}
Miscellaneous extractables	
Benzyl alcohol	73^{L}
Benzoic acid	$650^{L,B}$
Dibenzofuran	540^{L}
Hexachlorobutadiene	11^{B}
N-nitrosodiphenylamine	28^{B}
Volatile organics	
Tetrachloroethene	57^{B}
Ethylbenzene	10^{B}
Total xylenes	40^{B}
Pesticides	
p,p'-DDE	9^{B}
p,p'-DDD	16^{B}
p,p'-DDT	34^{B}

[a] Option 2 - Lowest AET among amphipod, oyster, and benthic:

A - Amphipod mortality bioassay
L - Oyster larvae abnormality bioassay
B - Benthic infauna
* - The sediment quality objective for human health has been established at 150 ppb for PCBs at the CB/NT site according to a method combining equilibrium partitioning and risk assessment methods.

7.3.1 Natural Recovery Process

Natural recovery of contaminated sediments is the process whereby the magnitude and extent of sediment contamination in the upper sediment layers is reduced over a period of time following significant reduction or elimination of contaminant sources that adversely impact sediment quality. Reductions in surficial sediment contamination are expected to result in corresponding reductions in environmental and public health risks.

The overall process of natural recovery of sediments is dependent on several specific processes:

- **Sediment accumulation and mixing:** Once existing sources are reduced or eliminated, cleaner sediment would tend to bury the more contaminated sediments. Biological and physical processes would also tend to mix the recently deposited, cleaner sediments with the contaminated sediments in the near-surface layers.
- **Biodegradation:** Microbial assemblages in the sediments break down many contaminants into less toxic forms.
- **Diffusive loss:** Contaminants adsorbed onto sediment particles may tend to dissolve into interstitial water (i.e., water in the sediments) then diffuse into the overlying water column.

These processes act at very different rates in reducing sediment contamination. The resultant recovery rates are also very site-specific, depending on factors such as sediment deposition rates, biological mixing activity, degrees of physical disturbance, biological productivity, and oxygenation of the sediments.

7.3.2 Relationship to Sediment Quality Objectives

In the feasibility study (Tetra Tech 1988a), natural recovery was evaluated as a potential means of achieving the sediment quality objective for the site. The advantages of natural recovery include:

- Long-term mitigation of environmental and health risks
- Avoidance of the potential adverse impacts of sediment cleanup operations (e.g., disturbance of existing benthic communities, redistribution of contaminants during dredging operations)
- Reduction in volumes requiring remediation with coincident increases in the feasibility of implementing sediment remedial activities
- Reductions in cost.

The disadvantages of natural recovery as an element of the selected remedy include:

- The continued risk of exposure during the natural recovery period
- Uncertainties regarding predictions of feasible levels of source control and estimated recovery rates
- Concern about the possibility of disturbance to a relatively thin natural cap (e.g., several inches of clean sediment) by physical (e.g., ship scour, wave erosion) and/or biological (e.g., burrowing) processes.

A mathematical model was developed in the feasibility study to quantitatively assess natural recovery in the CB/NT problem areas. The Sediment Contamination Assessment Model (SEDCAM) is a mass balance equation that predicts the sediment concentration of contaminants in relation to source loading, sedimentation rates, sediment mixing, biodegradation, and contaminant loss at the sediment-water interface. The model estimates the time required for sediment concentrations to decrease to levels considered acceptable (i.e., concentrations below chemical-specific sediment quality objectives). The model also allowed an evaluation of changes in areal extent of sediment problem areas given estimated levels of source control over varying timeframes. A 10-year timeframe for natural recovery was recommended in the feasibility study based on precedents in environmental legislation; the balance of remediation-related impacts relative to continued exposure, monitoring, and practicality; and requirements in the 1989 PSWQA plan (PSWQA 1988) to consider natural recovery, cost, and feasibility in developing sediment remedial guidelines.

Given sufficient levels of source control, natural recovery was predicted in the feasibility study (Tetra Tech 1988a) to reduce the volume of sediments requiring remediation at the CB/NT site by up to 40 percent. Natural recovery was shown to be effective within a 10-year period following source control in areas that were marginally contaminated above sediment quality objectives. The advantages of incorporating natural recovery as an element of the remedy appeared to outweigh the disadvantages in such circumstances. For example, concern about the integrity of the natural cap is offset by the relatively low impact of potential exposure to underlying sediments in marginally contaminated areas. Natural recovery was therefore considered an important mitigating factor in the feasibility study.

8. DESCRIPTION OF ALTERNATIVES

The purpose of the CB/NT feasibility study was to develop and evaluate the most appropriate remedial strategies for correcting the human health and environmental impacts associated with contaminated sediments in the CB/NT problem areas. The feasibility study described cleanup objectives for the site and then presented a range of alternatives that offered viable means of achieving those objectives.

Ten candidate alternatives were identified in the CB/NT feasibility study:

1. No-action
2. Institutional controls
3. *In situ* capping
4. Removal/confined aquatic disposal
5. Removal/nearshore disposal
6. Removal/upland disposal
7. Removal/solidification/upland disposal
8. Removal/incineration/upland disposal
9. Removal/solvent extraction/upland disposal
10. Removal/land treatment.

Although the names of the alternatives reflect characteristics of the specific sediment remedial action that they include, all candidate alternatives except the no-action alternative also include one or more of the following major elements:

- **Site use restrictions**—Protect human health by limiting access to edible resources prior to and during implementation of source and sediment remedial activities.
- **Source controls**—Implemented to prevent recontamination of sediments. Source control may be enhanced relative to existing programs, and consequently accelerate sediment remediation schedules by providing additional resources to focus activities on sources that contribute contaminants to sediments.
- **Natural recovery**—Included as an optional (and preferred) remediation strategy for marginally contaminated sediments that are predicted to achieve acceptable sediment quality through burial and mixing with naturally accumulating clean sediments.
- **Sediment remedial action**—Address sediments containing contamination that is expected to persist for unacceptable periods of time through confinement and treatment options.
- **Source and sediment monitoring**—Refine cleanup volume estimates, characterize the effectiveness of source controls, and ensure that the remedy is effective.

The way in which major elements are included in each candidate alternative is summarized in Table [illegible].

The following section summarizes the project cleanup objective. The next section describes the general characteristics of five major elements of the candidate alternatives and their interrelationships. This is followed by a description of the general characteristics of the 10 candidate

TABLE 6. MAJOR ELEMENTS OF THE 10 CANDIDATE ALTERNATIVES

Alternative	Element: Use Restriction	Element: Source Control	Element: Natural Recovery	Sediment Remedial Action: Confinement	Sediment Remedial Action: Treatment	Monitoring
1. No Action	No	Existing programs[a]	Yes	No	No	No
2. Institutional Controls	Yes	Enhanced	Yes	No	No	Yes
3. *In Situ* Capping	Yes	Enhanced	Preferred[b]	Yes	No	Yes
4. Removal/Confined Aquatic Disposal	Yes	Enhanced	Preferred	Yes	No	Yes
5. Removal/ Nearshore Disposal	Yes	Enhanced	Preferred	Yes	No	Yes
6. Removal/ Upland Disposal	Yes	Enhanced	Preferred	Yes	No	Yes
7. Removal/ Solidification/ Upland Disposal	Yes	Enhanced	Preferred	Yes	Yes	Yes
8. Removal/ Incineration/ Upland Disposal	Yes	Enhanced	Preferred	Yes	Yes	Yes
9. Removal/Solvent Extraction/ Upland Disposal	Yes	Enhanced	Preferred	Yes	Yes	Yes
10. Removal/ Land Treatment	Yes	Enhanced	Preferred	Yes	Yes	Yes

[a] No program enhancement or focus under federal Superfund.

[b] Presented as element of preferred alternative in CB/NT feasibility study (Tetra Tech 1988a).

alternatives and the sediment remedial action that distinguish them. A description of ARARs and other factors to be considered (TBCs) concludes the description of alternatives.

8.1 SEDIMENT CLEANUP OBJECTIVES AND EXTENT OF CONTAMINATION

The long-term sediment quality goal for Puget Sound, defined by PSWQA (1988) as the absence of acute or chronic adverse effects on biological resources or significant human health risk, was translated into a set of sediment quality objectives for the CB/NT site. The sediment quality objectives were defined in discrete, measurable terms relative to specific human health risk assessments and environmental effects tests and associated interpretive guidelines. As such, sediment quality objectives form the basis for both source control and sediment remedial actions. The process for developing these sediment quality objectives is described in greater detail in Sections 7.1.4 and 7.2.4 of this Record of Decision, in the feasibility study (Tetra Tech 1988a), and in the development of sediment cleanup goals (PTI 1988).

Sediment quality objectives were also translated into sediment remedial action levels and source control levels. Sediment remedial action levels incorporate technical feasibility and cost considerations by incorporating mitigating factors such as natural recovery. The sediment remedial action level differentiates areas that exceed the sediment quality objective, but are predicted to recover naturally, from those that are more significantly contaminated and therefore require active remediation to achieve the sediment quality objectives. If natural recovery is predicted to be effective in achieving the cleanup objective in a reasonable timeframe (10 years), then no sediment remediation would be required.

For sources, the relationship to the sediment quality objectives identified for the CB/NT site is less direct. Ecology's source control program will consider applicable state sediment standards (currently under development) which are also based on the long-term sediment quality goal for Puget Sound. Ecology's proposed source control requirements incorporate technical feasibility and cost considerations by requiring utilization of AKARTs and compliance with appropriate ARARs. Sediment quality standards (or interim values) will not explicitly be used to derive effluent limits, but they will be considered in the selection of appropriate treatment technologies.

In the feasibility study, sediment remedial alternatives were developed for two options: 1) active remediation of all sediments failing sediment quality objectives, and 2) active remediation of sediments failing remedial action levels and natural recovery of marginally contaminated areas. In both cases, the long-term overall project cleanup objective was to attain sediment quality objectives. Therefore, the extent of contamination in each problem area was estimated according to chemical exceedance of one or more of the sediment quality objectives.

Problem chemicals that exhibited the greatest elevation over effects indices (AET) over the greatest area were selected as indicator chemicals in the CB/NT feasibility study, and used to support the development and evaluation of remedial alternatives. The spatial distribution of indicator chemicals was used to estimate the volume of sediments exceeding the sediment quality objectives in the feasibility study and to determine the effect of source control and natural recovery.

8.2 KEY ELEMENTS OF CANDIDATE ALTERNATIVES

Candidate alternatives identified in the feasibility study were represented by specific combinations of source- and sediment-related activities that in most cases (i.e., excluding the no-action and institutional controls alternatives) were structured to achieve the project objective of acceptable sediment quality within a reasonable time. According to the feasibility study, this project objective was to be achieved by implementing the major elements of each candidate alternative in an interdependent, integrated fashion. Sediment remedial action was proposed after major sources were identified and controlled. Natural recovery of sediments was defined as an acceptable option if it was predicted to occur for all or part of a problem area within a reasonable time (i.e., within 10 years following the identification and control of major sources of contamination). Monitoring was described as most important in the early stages of remedial action to ensure that sources would be adequately controlled and to provide a baseline for future assessment of adequacy of source control, rate of sediment recovery, and permanence of sediment remedial action.

8.2.1 Site Use Restrictions

Site use restrictions consist mainly of public warnings to reduce potential exposure to site contamination, particularly ingestion of contaminated seafood. Local health advisories are an integral part of the overall remedy because the ultimate cleanup objective was projected to be achieved over a 10-15 year period.

8.2.2 Source Control

Source control activities specified for the 10 candidate alternatives are characterized as either *existing* programs or *enhanced* programs (Table 6). The designation *existing* programs indicates that no additional effort would be expended to accelerate implementation of these programs and subsequent sediment remedial action. *Enhanced* source control requires that additional resources be focused on identification of unknown sources, characterization of suspected sources, and control of known sources that are contributing contaminants to the high priority problem areas at the CB/NT site. *Existing* source control programs were focused on by the Commencement Bay UBAT following the remedial investigation. Source control efforts have recently been enhanced through a cooperative agreement between EPA and Ecology awarded 30 June 1989 (see Section 3.4). This expanded effort will ensure that sediment remedial action takes place in a timely fashion. Source control and remedial activities related to sources in Commencement Bay are broad-ranging in scope and status of action. For many sources (e.g., shipyards), the implementation of best management practices is the main form of remedial action. There is a variety of more traditional types of remedial action that have been or will be implemented to mitigate contamination at sources. These range from preliminary actions that address the most severe site contamination (e.g., site stabilization, expedited response action) to more comprehensive remedial measures (i.e., remedial design and remedial action). In general, appropriate source control actions have been identified on the basis of site-specific studies. Many of the ongoing source-related activities were initiated based on the results of the CB/NT remedial investigation (Tetra Tech 1985) and focus on problem areas and problem chemicals identified in the CB/NT remedial investigation. Source control actions for additional significant sources that are identified during the ongoing studies will be integrated into the overall remedy for each problem area.

In general, Ecology will use consent orders, consent decrees, and administrative orders to drive source-related activities. Orders and decrees, which can be issued at any time during the remedial process, may specify either a single action or numerous actions. One or more permits are also typically required to implement source controls. Many of the major sources in the CB/NT area are subject to NPDES or RCRA permits. In addition, special permits may be required for certain remedial activities (e.g., air quality permits for groundwater stripping of volatile organic compounds). A summary of major permits or regulatory mechanisms relevant to source control actions is presented in Section 3.

A summary of the status of source identification, characterization, and control efforts in the eight high priority areas addressed in this Record of Decision is provided in Table 7. Details of the process for determining the acceptability of source control efforts are described in Section [illegible]. Implementation schedules for this Record of Decision are summarized in Appendix C.

TABLE 7. STATUS OF SOURCE CONTROL ACTIVITIES IN COMMENCEMENT BAY NEARSHORE/TIDEFLATS PROBLEM AREAS

Site	Order/ Decree	Site Characterization		Site Remedial Action		NPDES Permit
		Status[a]	Completion Date	Status[a]	Completion Date	
Head of Hylebos Waterway						
Kaiser Aluminum & Chemical Co	1/90	U	9/89	P	90	11/89[b]
Pennwalt Chemical Corp.	6/87, 3/89	U	10/89	U	91	8/90[b]
General Metals, Inc.	8/87	C	7/89	U	12/89	12/89
3009 Taylor Way Log Sorting Yard	6/87, 90	U	6/90	P	91	
Wasser Winters Log Sorting Yard	3/87	U	89	P	12/90	
Louisiana Pacific Log Sorting Yard	6/87	C	6/89	P	10/90	
Cascade Timber Log Sorting Yard #2	2/90	P	90	P	93	
B&L Landfill	2/89, 8/90	U	6/90	P		
Tacoma Boatbuilding Co.	7/89	C	1/87	O		12/89
Storm drains						91
Additional source identification		O				
Mouth of Hylebos Waterway						
Occidental Chemical	11/88	U	9/89	P	91	3/90[b]
Storm drains						91
Additional source identification		O				
Sitcum Waterway						
Terminal 7				O		
Storm Drain SI 172		C	7/89	U	4/90	
Other storm drains						91
Additional source identification		O				
St. Paul Waterway						
Simpson Tacoma Kraft	12/85, 12/87			C	9/88	12/89[b]
Storm drains						91
Additional source identification		O				

TABLE 7. Continued

Site	Order/ Decree	Site Characterization Status[a]	Site Characterization Completion Date	Site Remedial Action Status[a]	Site Remedial Action Completion Date	NPDES Permit
Middle Waterway						
Cooks Marine Specialties				O		12/89
Marine Industries Northwest				O		12/89
Storm drains						91
Additional source identification		O				
Head of City Waterway						
American Plating	11/86, 9/87, 10/89		5/89	P	90	
Martinac Shipbuilding				O		1/90
Storm Drains CS 237, CN 237, CT 230		C	4/90	U		
Tacoma Spur site		O				
Other storm drains						91
Additional source identification		O				
Wheeler-Osgood Waterway						
Storm Drain CW 254		C	4/90	U		
Other storm drains					91	
Additional source identification		O				
Mouth of City Waterway						
D Street Petroleum	11/88, 91	U	12/89	P	92	
Storm drains					91	
Additional source identification		O				

[a] U - Underway
P - Planned
C - Completed with long term monitoring required
O - Ongoing element of overall source control effort.

[b] NPDES permit renewal date

8.2.3 Natural Recovery

In the CB/NT feasibility study, the advantages and disadvantages of including natural recovery were evaluated for all of the alternatives that include sediment remedial action. In the CB/NT feasibility study, two options were analyzed for each candidate remedial alternative that considered sediment remedial action: 1) remedial action alone achieves the sediment quality objective, and 2) natural recovery is considered acceptable for all portions of the problem area that are predicted to reach the sediment quality objective within 10 years, and sediments that are not predicted to achieve this objective are subject to remedial action. Natural recovery of some or all of a given problem area may occur through chemical degradation, diffusive losses of contaminants across the sediment-water interface, and burial and mixing of contaminated surface sediments with recently deposited, clean sediments.

Natural recovery is expected to be effective in marginally contaminated portions of each problem area, but it is not intended to address severe levels of contamination. To determine the cleanup level, a recovery factor was developed using the mathematical model SEDCAM (described in Section 7.3.2). Recovery factors represent the ratio of the cleanup level to the sediment quality objectives for different chemicals. Recovery factors developed in the CB/NT feasibility study ranged from 1.2 to 4.6 for different indicator chemicals in the different problem areas. That is, in some areas sediments contaminated at up to 4.6 times the sediment quality objective were predicted to recover within 10 years following source control. The value of a recovery factor is a function of the source loading rate, sedimentation rate, depth of the surface sediment mixed layer, and chemical degradation. Recovery factors identified in the feasibility study were based on limited data, and will be further developed as a result of continued source investigation and monitoring, additional sediment sampling conducted during remedial design, and emerging information on other processes (e.g., sediment resuspension, new degradation rate data) that may alter recovery rates and the feasibility study (Tetra Tech 1988a).

8.2.4 Sediment Remedial Action

Sediment remedial action is directed at sediments that exceed the sediment quality objective or are predicted to exceed the sediment quality objective within 10 years (if the natural recovery option is included in the overall site remedy). Sediment remedial action falls into the general categories of confinement and treatment (Table 6). Confinement remedies isolate contaminated sediments but do not decrease toxicity, mobility, or volume. Treatment alternatives include technologies that destroy or entrap problem chemicals, effectively reducing toxicity, mobility, or volume. Details of the sediment remedial action that characterizes the 10 candidate alternatives are described in Section 8.3 and the feasibility study (Tetra Tech 1988a).

8.2.5 Monitoring

Source and sediment monitoring are critical for determining the success of individual remedial actions and ensuring that all necessary remedial actions have been undertaken in a problem area. The overall objective of source monitoring is to document the level of source control achieved and the attainment of environmental quality goals. Sediment monitoring will include a combination of chemical and optional biological tests as summarized in Section 8.1. Further detail regarding sampling design and monitoring is provided in the CB/NT feasibility study (Tetra Tech 1988a) and in the integrated action plan (PTI 1988). Sampling and test evaluation protocols for environmental effects, as well as the AET database, are to remain consistent with any adjustments adopted by the Puget Sound Estuary Program. New tests will only be considered if they are adopted as replacements for one of the three biological indicators described in this Record of Decision. When both biological and chemical test results are available for a particular sediment sampling station, the results of a particular biological test will outweigh the AET predictions of that biological effect based on chemistry.

Source monitoring data are collected as part of the source control programs discussed above in Section 8.2.2. During sediment remedial design, monitoring of poorly characterized sources may also be necessary to refine estimates of the importance of source control at those facilities. This monitoring may be coordinated with reconnaissance surveys designed to assess the relative importance of ongoing and historical sources of contamination.

Monitoring of sediment contamination is conducted before and after sediment remediation and serves the following purposes:

- Baseline sediment sampling during remedial design and again during remedial action establishes a recent basis for assessing the success of the remedial alternative
- Monitoring is used to confirm predicted recovery of problem sediments within a reasonable time period (10 years) when sediment remedial action is not required for all or a portion of the cleanup volume
- Post-remedial action monitoring enables assessment of the success of source control efforts and provides a record indicating that the sediment problem has been mitigated (e.g., successful operation of a disposal facility).

Baseline monitoring requirements are satisfied by sampling conducted during remedial design to refine the estimated cleanup volume and during sediment remedial action to serve as a baseline for evaluating natural recovery processes. Additional monitoring may be advisable depending on the time lapse before implementation of the sediment remedial alternative.

The recommended frequency of sediment monitoring depends on the documented success of source control. Annual sampling for sediment chemistry and biological effects is recommended for the first several years following implementation of sediment remedial action. If results confirm that sources have been adequately controlled, then the frequency can be decreased. For well controlled sources or in the absence of ongoing sources, sediment monitoring is used primarily to determine the success of sediment remedial action. When only partial source control is possible, more frequent sediment monitoring may be necessary to determine the need for subsequent sediment remedial action.

8.3 CANDIDATE ALTERNATIVES

Each candidate alternative represents a combination of the major elements described above. Implicit in each of the identified alternatives (except no-action) is the aggressive pursuit of source control measures under all existing environmental authorities to reduce contaminant inputs to sediments to the maximum extent possible using AKARTs. The level of source control was considered in evaluating alternatives to assess long-term effectiveness and the potential for natural recovery. Details of these candidate alternatives are presented in the feasibility study (Tetra Tech 1988a).

8.3.1 Alternative 1: No-Action

The no-action alternative supplies a baseline against which other sediment remedial alternatives can be compared. Under the no-action alternative the site would be left largely unchanged, with no remediation of sediment contamination, although some degree of natural recovery may be evident in areas impacted by historical sources. This alternative does nothing to mitigate the public health and environmental risks associated with the site, but its evaluation is required by the NCP. Absence of any additional resources for source control through an EPA/Ecology cooperative agreement under Superfund is an implicit element of this alternative. Potential impacts of the no-action alternative include the following:

- Continued potential for human health effects associated with consumption of contaminated fish and shellfish
- Continued high incidence of fish disease (e.g., liver lesions)
- Continued bioaccumulation of problem chemicals in the aquatic food chain
- Continued depressions of the benthic communities (reducing the value of contaminated areas as habitat for fishery resources)
- Continued acute and chronic toxicity for marine organisms associated with sediments.

8.3.2 Alternative 2: Institutional Controls

Institutional controls include access restrictions, limitations on recreational use of nearshore areas, issuance of public health advisories, monitoring to evaluate changes in sediment characteristics, and most important, enhanced regulatory control of contaminant sources specifically oriented toward mitigation of sediment contamination. Limitations on access and recreation (e.g., fishing, diving) reduce human exposure and risk to public health, but do nothing to mitigate the existing environmental impact mentioned under the no-action alternative. Some degree of long-term mitigation is expected as a result of reduction in source loadings. Sediment monitoring is included in this alternative to permit identification of contaminant migration patterns and assess sediment recovery associated with source control. Monitoring would be designed to enable assessment of changes in risks to public health and the environment before impacts are realized.

8.3.3 Alternative 3: *In Situ* Capping

In situ capping involves containment and isolation of contaminated sediments through placement of clean material on top of existing substrate. The capping material may be clean, dredged material or fill (e.g., sand). In addition, it may be feasible to include additives (e.g., bentonite) to reduce the hydraulic permeability of the cap or sorbents to inhibit contaminant migration. Both mechanical and hydraulic dredging equipment can be used for *in situ* capping operations. Cohesive, mechanically dredged material would be placed by using a split-hulled barge. Hydraulically dredged material would be placed by using a downpipe and diffuser. Depending on site topography, diking may be necessary along a margin of the capped sediments to provide lateral cap support.

For the purposes of evaluating the capping alternative and estimating costs, it was assumed that clean, dredged material from the Puyallup River would be used to construct the cap. Although *in situ* capping has been successfully conducted with hydraulic dredging equipment, for costing purposes it was assumed that the capping material would be dredged using a clamshell dredge to maintain cohesiveness, transported to the problem areas, and deposited hydraulically to create a cap with a minimum thickness of 3 feet. Evaluation during design may dictate placement of additional capping material to prevent failure due to erosion or diffusion of mobile contaminants.

8.3.4 Alternative 4: Removal/Confined Aquatic Disposal

Several confined aquatic disposal options were described in the CB/NT feasibility study. These options include waterway confined aquatic disposal, shallow-water confined aquatic disposal, open-water confined aquatic disposal, and open-water mounded confined aquatic disposal. These options differ from one another based largely on location, depth, and physical characteristics of the disposal site. Design features of an in-waterway confined aquatic disposal site are illustrated in Figure 14. Mechanical dredging followed by split-hulled barge placement techniques can be used to implement this alternative. The thickness of the cap required for confined aquatic disposal options ranges from 3 to 6 feet, depending on wave and tidal energies and water depth at the disposal site. Onsite confined aquatic disposal could be implemented within a designated shipping area. This approach would entail dredging an area well below the zone of contamination.

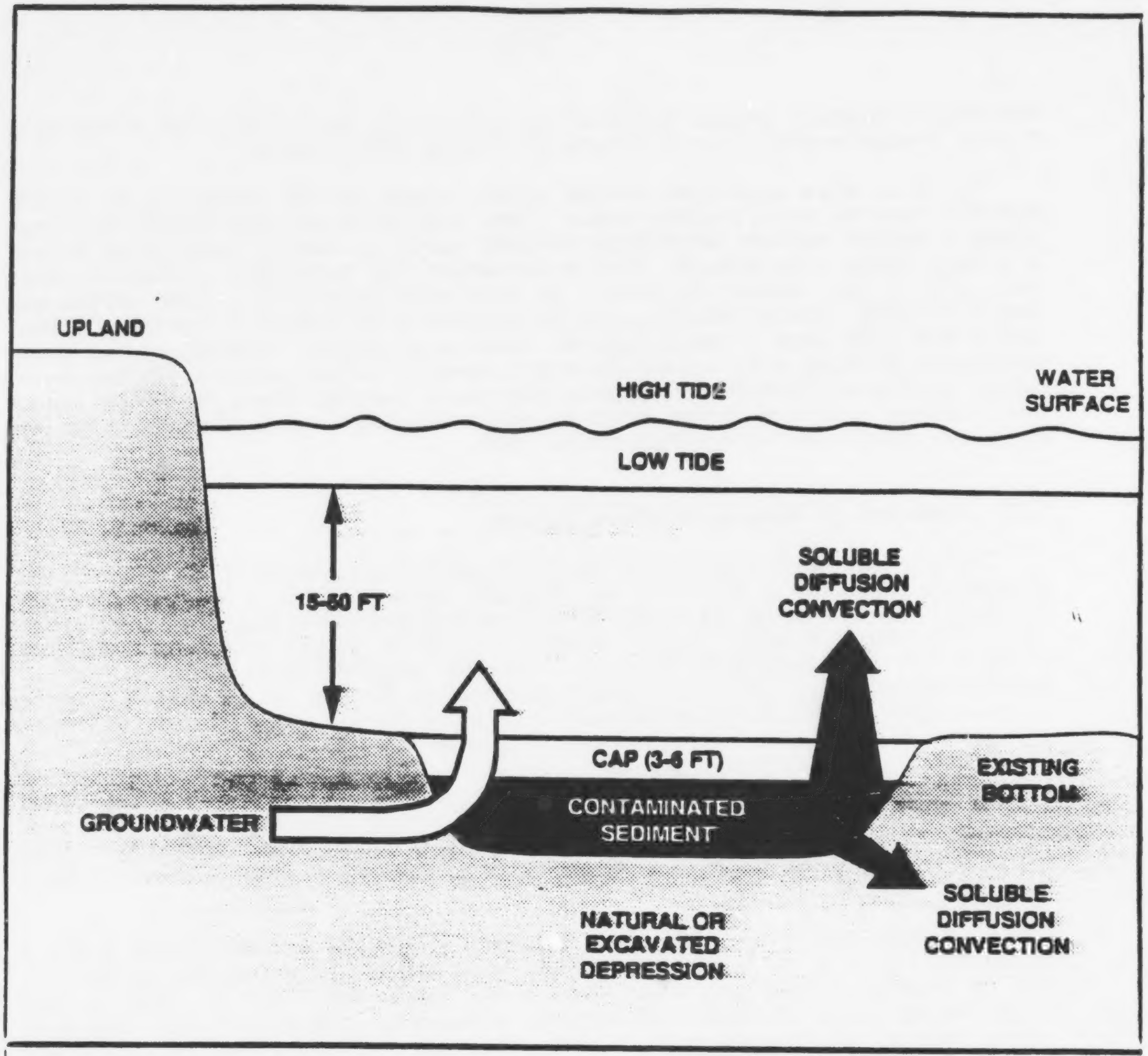

UPLAND
HIGH TIDE
WATER SURFACE
LOW TIDE
15-50 FT
SOLUBLE DIFFUSION CONVECTION
CAP (3-6 FT)
EXISTING BOTTOM
GROUNDWATER
CONTAMINATED SEDIMENT
SOLUBLE DIFFUSION CONVECTION
NATURAL OR EXCAVATED DEPRESSION

Figure 14. In-waterway confined aquatic disposal of contaminated dredged material

depositing contaminated dredged material in the excavated pit, and capping it with a thick layer of clean, dredged material if future navigational dredging were anticipated.

Use of an offsite open-water confined aquatic disposal site was assumed in the CB/NT feasibility study for costing purposes because a deep-water site of sufficient capacity for a large volume of material had been identified as potentially viable. A clamshell dredge would be used to maintain nearly *in situ* densities. Also, by minimizing water entrainment, a clamshell dredge would result in easier transport and fewer or less severe water quality impacts during dredging and disposal operations. Dredged materials would be transported to the disposal site and placed directly using a split-hulled barge to limit bulking and water column impacts. Capping materials would subsequently be placed in the disposal site using a submerged diffuser system to minimize water column turbidity and facilitate more accurate placement of materials. Use of the diffuser system would eliminate upper water column impacts by radially dispersing the material parallel to and just above the bottom at low velocity (Phillips et al. 1985).

8.3.5 Alternative 5: Removal/Nearshore Disposal

Dredging followed by confined disposal in the nearshore environment is another alternative for sediment remediation at the CB/NT site. Generally, nearshore sites must be diked before they can receive dredged material. There are essentially no limitations in the selection of dredging and transport equipment, although hydraulic dredging followed by pipeline transport to the disposal facility is considered optimal (Phillips et al. 1985). All variations considered for the removal/nearshore disposal option use industry standard equipment and methods that are generally available. Hydraulic dredging confines dredged material to a pipeline during transport, thereby minimizing exposure potential and handling requirements. Systems for management and treatment of dredge water can be readily incorporated into the facility design. The distances between several of the problem areas and a tentatively identified Blair Waterway nearshore disposal site are great. Material dredging with a clamshell system would be used for implementing this alternative in problem areas more than 2 miles from the disposal site. For problem areas within 2 miles, a hydraulic dredging system would be possible. Logistical problems may be encountered, however, in areas with heavy marine traffic.

A schematic drawing depicting general features of a nearshore confined disposal facility is presented in Figure 15. To accommodate a dredge water control system using chemical flocculation, the secondary settling basin would resemble that illustrated in Figure 16. Other assumed design features include fill depth of 30 feet and a minimum cap thickness of 3 feet. Additional capping material may be required to facilitate subsequent construction over the confinement facility. The facility was assumed to be unlined.

For the purpose of evaluating this alternative in the feasibility study, it was assumed that the nearshore disposal facility in Blair Waterway would be used. For the Record of Decision, this alternative was evaluated and costs were developed assuming disposal was incorporated into planned construction projects.

8.3.6 Alternative 6: Removal/Upland Disposal

Dredging followed by upland disposal would involve the transfer of dredged material to a land-based confinement facility and would be implemented following source control. Sediment could be dredged either mechanically or hydraulically and transferred to the disposal site by truck, rail, or pipeline. As in the case of nearshore disposal, the alternative can be implemented using standard dredging and transport equipment that is generally used for similar operations. Provisions would be required for the management of dredge water and leachate generated during the dewatering process. Disposal site design features would include a liner and cap. The liner system would include an underdrainage system for dewatering the fill material and for controlling leachate over the long term. The underdrainage system would be designed to operate as either a passive collection system or a vacuum-assisted dewatering system.

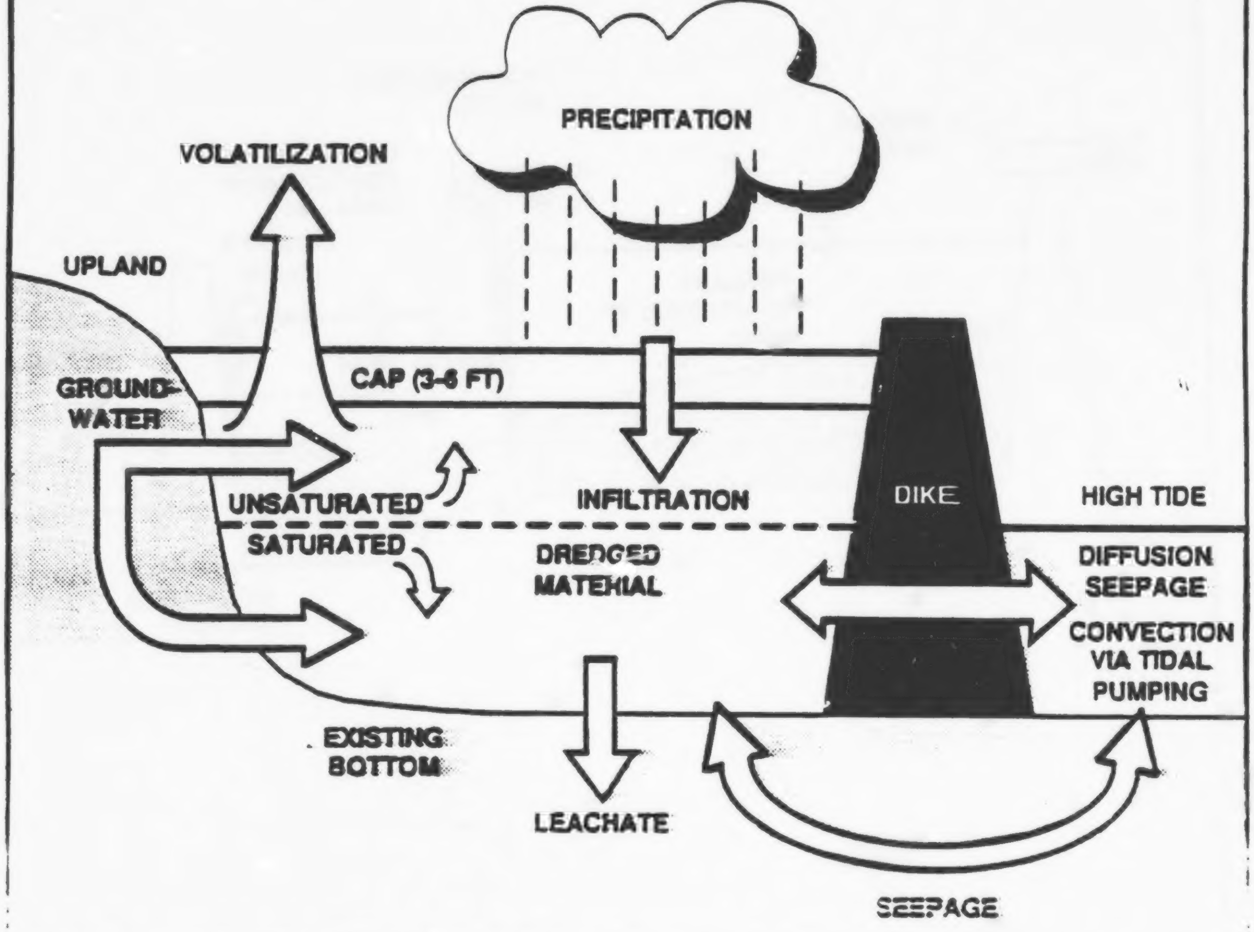
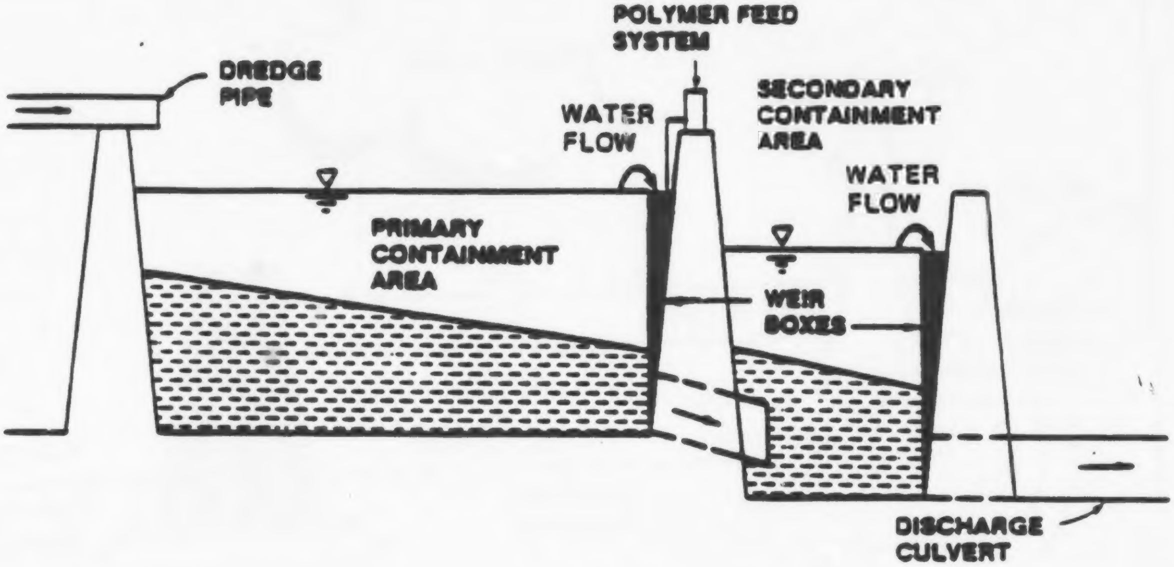

PRECIPITATION
VOLATILIZATION
UPLAND
CAP (3-6 FT)
GROUND-WATER
UNSATURATED
SATURATED
INFILTRATION
DIKE
HIGH TIDE
DREDGED MATERIAL
DIFFUSION SEEPAGE
CONVECTION VIA TIDAL PUMPING
EXISTING BOTTOM
LEACHATE
SEEPAGE

Figure 15. Confined nearshore disposal of contaminated dredged material


POLYMER FEED SYSTEM
DREDGE PIPE
WATER FLOW
SECONDARY CONTAINMENT AREA
WATER FLOW
PRIMARY CONTAINMENT AREA
WEIR BOXES
DISCHARGE CULVERT

Reference: Phillips et al. 1985.

Figure 16. Dredge water chemical clarification facility

A schematic drawing of an upland confinement facility is presented in Figure 17. Dredge water clarification (e.g., using the secondary settling basin and chemical clarification design shown in Figure 16) would be an essential feature of the facility. It was assumed that the disposal facility would be constructed to contain contaminated dredged material to a depth of 15 feet. A dual synthetic liner and passive underdrainage system would be included to permit removal of percolating dredge water and allow for long-term leachate collection. Dredged material would settle, and ponded dredge water would be removed. Passive collection of percolating water would continue until the fill consolidates to an extent that allows capping operations to commence. The upland landfill would be lined with a synthetic liner material or clay and would have an underdrainage system. The cap would be 2 feet thick and would be composed of clay.

For the purpose of evaluating this alternative, it was assumed that an upland disposal site would be developed within 3 miles of the problem area to meet the CERCLA preference to avoid the offsite transport and disposal of untreated waste. Compared to the *in situ* capping and nearshore disposal alternatives, additional time would be required prior to implementation to allow for siting and development of an upland disposal facility. Dredging would be conducted using a pipeline cutterhead dredge, and material would be hydraulically transported to the disposal site.

8.3.7 Alternative 7: Removal/Solidification/Upland Disposal

Solidification, in conjunction with clamshell dredging and upland disposal, is another option for treatment of contaminated dredged material. Treatment by solidification could be conducted at either nearshore or upland disposal sites. Either hydraulic or mechanical dredging equipment could be used to remove the contaminated sediment. In the former case, sedimentation to remove most of the dredge water would be required prior to blending in the solidification agents. As discussed in the CB/NT feasibility study, several solidification agents and implementation scenarios are feasible for this treatment option, although none has been field tested with marine sediments.

Design features for the disposal facility would depend on the hazard level of the solidified sediment. In developing this alternative, it was assumed that the treated material would not be a RCRA hazardous waste and that the confinement facility would be designed to satisfy minimum functional standards for landfills in accordance with state regulations (WAC 173-304). The liner would be composed of clay or be a synthetic liner, which would meet the maximum permeability standard of 1×10^{-7} cm/second. An underdrainage system atop the liner would remove dredge water. The facility would accommodate a 15-foot fill depth and be capped with 2 feet of clay to meet a permeability standard of 1×10^{-6} cm/second.

For the purpose of developing cost estimates, it was assumed that a cement/pozzolanic process would be used. For the evaluation of this alternative, contaminated sediments were assumed to be mechanically dredged and transported to the upland site. Dredged material would be staged in hoppers and fed by a screw conveyor system for solidification. Mixing would be completed in a treatment facility with in-line mixing of solidification agents. Discharge would be either directly to the confinement facility or to a truck for transport to the facility. Curing times for the process may be extended as a result of the salt content of the dredged material.

8.3.8 Alternative 8: Removal/Incineration/Upland Disposal

Although incineration permanently eliminates organic contamination in sediments, this alternative has limited application in the CB/NT site for two reasons. First, most problem areas are characterized by significant metals contamination, which is not mitigated by incineration. Second, marine sediments are characterized by very low Btu content, making incineration extremely energy-intensive and less cost-effective. As for the other alternatives, implementation of source control measures was assumed.

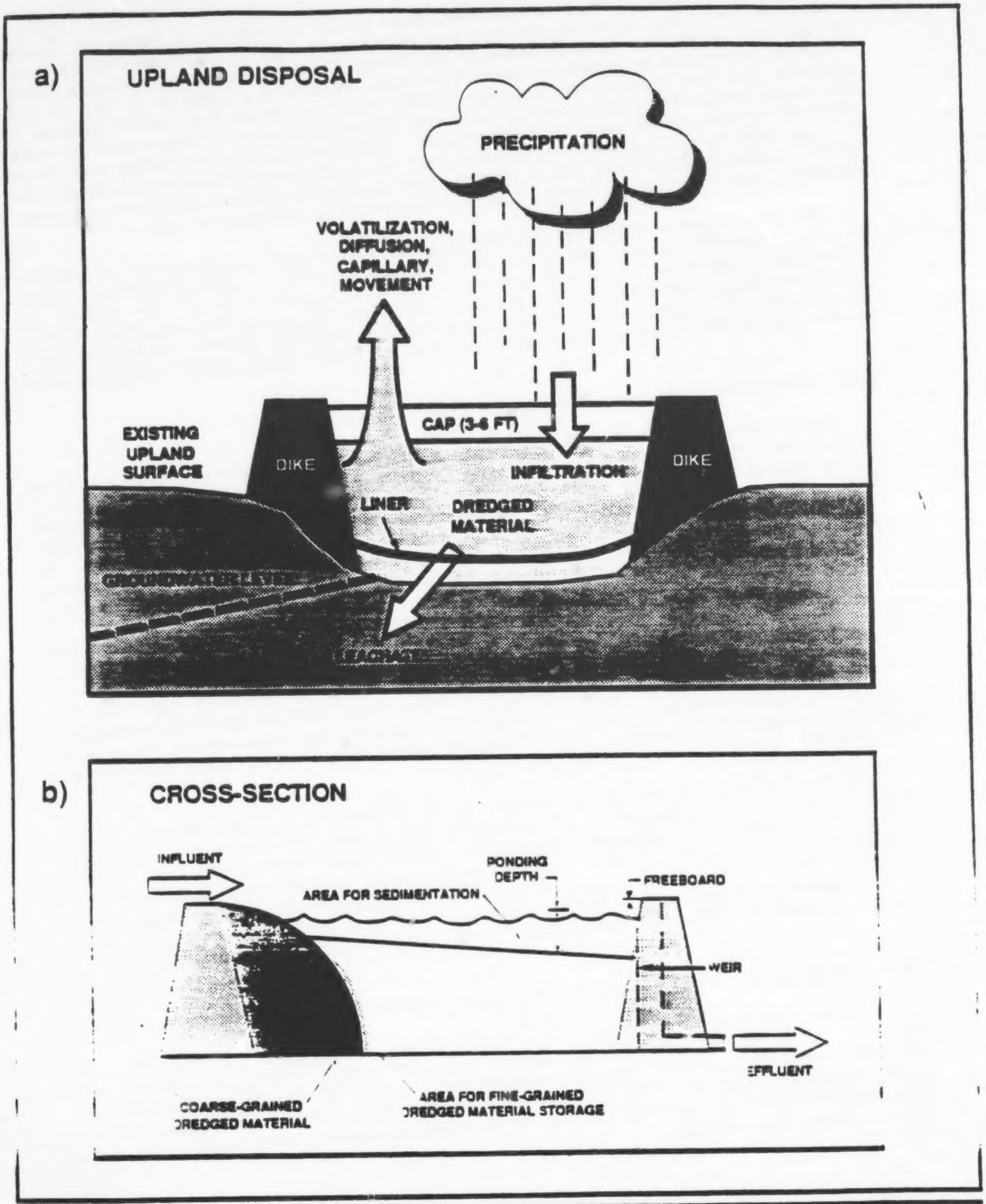

a)
UPLAND DISPOSAL
PRECIPITATION
VOLATILIZATION, DIFFUSION, CAPILLARY, MOVEMENT
CAP (3-6 FT)
EXISTING UPLAND SURFACE
DIKE
INFILTRATION
DIKE
LINER
DREDGED MATERIAL
GROUNDWATER LEVEL
LEACHATE
b)
CROSS-SECTION
INFLUENT
PONDING DEPTH
FREEBOARD
AREA FOR SEDIMENTATION
WEIR
EFFLUENT
COARSE-GRAINED DREDGED MATERIAL
AREA FOR FINE-GRAINED DREDGED MATERIAL STORAGE

Figure 17. Confined upland disposal (a) and components of a typical diked upland disposal site (b)

For this alternative, sediments were assumed to be mechanically dredged, using a watertight clamshell bucket to minimize water content of the dredged material, minimize water column partitioning of contaminants, and maintain *in situ* sediment densities. The dredged material would be transported to shore by barge and then to an upland site for incineration. It is possible that an incinerator could be located adjacent to the problem area and transport by truck could be avoided. Analysis of the incinerated residue may reveal that the material no longer requires special handling and confinement. Open-water disposal may be a feasible option for disposal of incinerated contaminated dredged material, but for this alternative, disposal in a minimum security landfill was assumed for evaluation.

8.3.9 Alternative 9: Removal/Solvent Extraction/Upland Disposal

For sediments containing primarily organic contaminants, solvent extraction followed by incineration of the organic concentrate would be a feasible alternative. This approach to sediment remediation would result in permanent removal and destruction of organic compounds. It was assumed that contaminated sediments would be dredged using a clamshell, transported via barge, and offloaded using a clamshell to an onshore treatment facility. The contaminated dredged material would be treated, dried, and transported to an upland disposal facility. Because the process effectively dewaters the solids, stabilization was considered unnecessary.

For the purpose of evaluating this alternative, use of the BEST® technology marketed by Resources Conservation Company (Bellevue, Washington) was assumed. Effluents from the process would include wastewater and treated solids, and a concentrated organic waste that might require additional treatment. Solids retain a low residual concentration of extracting solvent, and depending on metals content, may be returned to the removal site for unconfined disposal, placed in a PSDDA open-water disposal site, or landfilled in a secure facility. The latter was assumed for estimating costs. The extracting solvent, typically triethylamine, is not a listed hazardous waste constituent, which simplifies waste solids and wastewater disposal.

8.3.10 Alternative 10: Removal/Land Treatment

For sediments contaminated with biodegradable organic compounds, a land treatment option was considered. Land treatment involves the incorporation of waste into the surface zone of soil, followed by management of the treatment area to optimize degradation by natural soil microorganisms. Chemical and physical characteristics of the waste need to be evaluated to determine the amount that can safely be loaded onto the soil without adversely impacting groundwater. Soils possess substantial cation exchange capacity, which can effectively immobilize metals. Therefore, wastes containing metals can be land-treated, but careful consideration of the assimilative capacity of the soil for metals is essential.

For evaluating this alternative, it was assumed that source control would be implemented and that sediments would be removed using a clamshell dredge to minimize water content of the dredged material. After transport by barge and truck to the land treatment facility, the sediment material would be distributed and tilled into the upper 15-30 cm of soil. The land treatment facility design would prevent stormwater run-on and allow collection and management of runoff. Lysimeters and monitoring wells would be installed and periodically sampled to aid in the detection of subsurface contaminant migration.

8.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Remedial actions implemented under CERCLA must meet legally applicable or relevant and appropriate requirements (ARARs). ARARs include promulgated environmental requirements, criteria, standards, and other limitations. Other factors to be considered (TBCs) in remedy selection may include nonpromulgated standards, criteria, advisories, and guidance, but are not evaluated pursuant to the formal process required for ARARs. ARARs of federal, state, and tribal governments must be complied with during CERCLA response actions. Local ordinances with promulgated criteria or standards are not considered ARARs but may represent important TBCs. Major chemical-specific, location-specific, and action-specific ARARs and TBCs are presented in Tables 8, 9, and 10.

TABLE 8. MAJOR CHEMICAL-SPECIFIC ARARs FOR REMEDIAL ALTERNATIVES

Media	Citation	Requirement	Prerequisites for Applicability
Surface Water			
ARARs[a]			
Clean Water Act	33 U.S.C. Section 1251 Clean Water Act Section 301(b)	Direct discharges must meet technology-based standards	All direct discharges; applies to sources only
	33 U.S.C. Section 1251 40 CFR 125.120-125.124 40 CFR 227.22 Clean Water Act Section 403	Establishes limiting permissible concentrations for discharge into marine waters	Discharges to marine waters; applies to sources and sediment
	33 U.S.C. Section 1251 40 CFR 131 (U.S. EPA 1986)	Ambient water quality criteria for protecting aquatic organisms and human health	Fresh and marine waters; applies to sources and sediment
Washington Water Quality Standards	WAC 173-201	Water quality standards for surface waters	Surface waters of the state of Washington (conventional water quality parameters only); applies to sources and sediment
Puyallup Tribe Water Quality Program	Puyallup Tribal Council Resolution No. 151288C	Interim tribal water quality standards adopting Washington water quality standards	Surface waters of the state of Washington (conventional water quality parameters only); applies to sources and sediment
Water Pollution Control Act and Water Resources Act	RCW 90.48 and RCW 90.54	Requires use of all known available and reasonable methods of treatment (AKARTs) for controlling discharges to surface water	All direct discharges; applies to sources only
TBCs[b]			
Puget Sound Water Quality Authority Management Plan	PSWQA Plan (1988) Elements P-6 and P-7	Effluent limits for toxicants and particulates	NPDES or state waste discharge permits; applies to sources only

TABLE 8. (Continued)

Media	Citation	Requirement	Prerequisites for Applicability
Critical Toxicity Values Advisories (reference doses, carcinogenic potency factors)	Integrated Risk Information System, EPA Office of Health and Environmental Assessment Health Effects Assessments, Health and Environmental Effects Documents, and health advisories from the EPA Office of Research and Development and Office of Water	Toxicology indices used for estimating health risks	For use in conducting risk assessments; applies to both sources and sediment
Groundwater			
ARARs			
Clean Water Act	33 U.S.C. Section 1251 40 CFR 131 (U.S. EPA 1986)	Ambient water quality criteria for protecting aquatic organisms and human health	Groundwater on the site; applies to both sources and sediment (different standards may apply to different aquifer zones)
Resource Conservation and Recovery Act (RCRA)	40 U.S.C. 6901 40 CFR 264.110-264.120, 265.110-265.120	Closure and post-closure performance standards	RCRA facility closure; applies to sources only
	40 CFR 264.90-264.101, 265.90-265.94	Groundwater protection standards [maximum contaminant levels (MCLs)] must be met	RCRA facility; applies to sediment (upland disposal)
Safe Drinking Water Act National Primary Drinking Water Standards	42 U.S.C. Section 300f *et seq.* 40 CFR 141 40 CFR 143	MCLs for maximum allowable levels of contaminants in public drinking water	Groundwater used as public drinking water; applies to sediment (upland disposal)
		Secondary MCLs for aesthetic qualities of public drinking water	Groundwater used as public drinking water; applies to sediment (upland disposal)

TABLE 8. (Continued)

Media	Citation	Requirement	Prerequisites for Applicability
Water Pollution Control Act and Water Resources Act	RCW 90.48 and RCW 90.54	Requires use of AKARTB for controlling discharges to groundwater	All direct discharges; applies to sources only
Air			
ARARs			
Clean Air Act	42 USC Section 7401 *et seq.* 40 CFR Part 50	Ambient air quality standards for chemicals and particulates	Air quality presently onsite or during treatment; applies to sources and sediment
TBCs			
Puget Sound Air Pollution Control Agency guidelines	Puget Sound Air Pollution Control Agency guidelines for acceptable ambient levels (AAL)	Sources must meet AAL guidelines	Action will produce air emissions; applies to sources and sediment
Sediment, Soils, and Solid Waste			
ARARs			
Toxic Substances Control Act	15 USC 2601 *et seq.* 40 CFR 761	Soil cleanup level for PCBs	PCB contaminated soils; applies to sources only (soils)
RCRA	42 USC 6901 40 CFR 261.24	EP toxicity test for contaminant leaching triggers handling and disposal requirements	Contaminated soils and sediments requiring land-based disposal
TBCs			
Puget Sound Dredged Disposal Analysis (PSDDA)	PSDDA (1988)	Chemical and biological criteria for dredged material disposal in Puget Sound	Disposal of dredged material suitable for open water, unconfined sites in Puget Sound; applies to sediment only

ABLE 8. (Continued)

Media	Citation	Requirement	Prerequisites for Applicability
Puget Sound Water Quality Management Plan (PSWQA 1988)	PSWQA Plan (1988) Element P-2	Sediment quality standards for contaminated sediments	Actions involving sediments having adverse biological effects or human health risk; applies to sediment
	PSWQA Plan (1988) Element P-3	Criteria for sediment impact zones and dilution zones	Wastewater discharges with dilution zones; applies to sources and sediment
	PSWQA Plan (1988) Element S-4	Regulations for disposal of dredged material exceeding Element P-2 standards	Dredged material requiring confined disposal; applies to sediment only
	PSWQA Plan (1988) Element S-7	Guidelines for sediment cleanup decisions	Applies to sediment exceeding Element P-2 standards
iological Resources			
TBCs			
Food and Drug Administration	49 CFR 10372 10442	Maximum concentrations of contaminants in fish tissue	Interstate commerce of fish; applies to sources and sediment

Applicable or relevant and appropriate requirements.

Other factors to be considered.

TABLE 9. MAJOR LOCATION-SPECIFIC ARARs FOR REMEDIAL ALTERNATIVES

Location	Citation	Requirement	Prerequisites for Applicability
ARARs[a]			
Within 100-year flood plain	40 CFR 264.18(b)	Facility must be constructed, maintained, and operated to prevent washout	RCRA hazardous waste treatment, storage, and disposal; applies to sources and sediment
Within floodplain	Executive Order 11988 40 CFR 6 Appendix A	Action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values	Action will occur in lowlands and flat areas adjoining inland and coastal waters
Wetland	Executive Order 11990 40 CFR 6 Appendix A	Action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values	Action will destroy, modify, or develop wetlands; applies to sources and sediment
Oceans or waters of the United States	Clean Water Act Sections 404 and 401 40 CFR 125	Action to dispose of dredged and fill material requires a permit	Actions in oceans and waters of the United States; applies to sediment only
	Rivers and Harbors Appropriations Act Section 10	Actions which obstruct or alter a navigable waterway require a permit	Obstruction or alteration of a navigable waterway; applies to sediment only
Commencement Bay/ Puyallup River Watershed	Puyallup Tribe of Indians Settlement Act of 1989, PL-101-41, 103 STAT. 83 (21 June 1989)	Observe tribal environmental standards, and standards and requirements for cultural and religious preservation	Activities affecting environmental quality including fisheries, habitat, surface water, and groundwater; applies to sources and sediment
		Enhance fisheries resources	Actions which impact fisheries resources; applies to sediment only
Within state of Washington hazardous waste site	Model Toxics Control Act (Initiative 97, Chapter 2 (RCW), Laws of 1989	Imposes substantive cleanup standards	Source control actions taken at state hazardous waste sites

TABLE 9. (Continued)

Location	Citation	Requirement	Prerequisites for Applicability
Contaminated property	Hazardous Waste Management Act, Chapter 70.105 (WAC 173-303-420)	**Presence of hazardous wastes**	**Source control actions at areas of contamination**
Within 200 feet of shoreline	Shoreline Management Act, RCW 90.58	**Substantive permit requirement**	**Actions impacting within 200 feet of shoreline**
TBCs[b]			
Wetland	EPA Wetlands Action Plan, EPA Office of Water and Wetland Protection (January 1989)	**No net loss of remaining wetlands base**	**Dredge and disposal of dredged material in wetlands**

[a] **Applicable** or relevant and appropriate requirements.

[b] **Other factors** to be considered

TABLE 10. MAJOR ACTION-SPECIFIC ARARs FOR REMEDIAL ALTERNATIVES

Action	Citation	Requirement	Prerequisites for Applicability
ARARs[a]			
Upland disposal (closure) of RCRA hazardous waste	40 CFR 264.111, 264.228, 264.258, 264.310 52 CFR 8712	Removal of all contaminated material	RCRA hazardous waste placed at site, or movement of waste from one area to another; applies to sources only
Upland disposal (containment) of RCRA hazardous waste	40 CFR 264.220, 264.221, 264.301, 264.303, 264.304, 264.310, 264.314, 268 Subpart D	Construction of new landfill onsite; design, maintenance, and operation requirements	RCRA hazardous waste placed in new landfill; applies to sources only
Upland disposal (post closure)	40 CFR 264	Monitoring requirements	RCRA hazardous waste; applies to sources only
Upland disposal of solid waste or dangerous waste	WAC 173-304	Functional standards for solid waste handling	Material classified as solid waste; applies to sources and sediments
	WAC 173-303-070-110	Designation of material as dangerous waste	Material classified as dangerous waste; applies to sources and sediment
	WAC 173-303-141	Treatment, storage, and disposal of dangerous waste	Material classified as dangerous waste; applies to sources and sediment
	WAC 173-303-400, 420, 600, 610-670	Provisions for facility design, maintenance, and closure	Soils and sediments classified as dangerous waste requiring land-based disposal

ABLE 10. Continued

Action	Citation	Requirement	Prerequisites for Applicability
Dredging and disposal of dredged material open-water and near shore	Clean Water Act Section 401 40 CFR 125	**Dredging in waters of the United States requires a permit; action to dispose of dredged material requires a permit**	**Waters of the United States; applies to sediment only**
	Clean Water Act Section 401 40 CFR 125	**Dredging or aquatic disposal of dredged material requires state water quality certification**	**Applies to sediment only**
	RCW 75.20.100 WAC 220-110	**Requirement for a hydraulics permit**	**Interference with natural water flow of Washington state waters; applies to sediment only**
Any action affecting the marine environment	Puyallup Tribe of Indians Settlement Act of 1989, PL-101-41, 103 STAT. 83 (21 June 1989)	**Ensure substantial restoration and enhancement of fisheries resources**	**Activity must impact fisheries resources; applies to sources and sediments**
	Puyallup Tribal Council Resolution No. 151288C	**Interim tribal water quality standards adopting Washington water quality standards**	**Surface waters of the state of Washington (conventional water quality parameters only); applies to sources and sediment**
Upland disposal (groundwater protection)	40 CFR 264.90-264.101, 265.90-265.94	**Groundwater monitoring at RCRA disposal facilities and general protection requirements**	**RCRA hazardous waste; applies to sources and sediment**
Incineration of dredged material	40 CFR 264.340-264.999, 265.270-265.299	**Requirements for incineration of RCRA hazardous waste**	**RCRA hazardous waste; applies to sources and sediment**
	Puget Sound Air Pollution Control Agency permit issuance	**Requirements for incinerators to achieve local standards, new source requirements**	**Applies to sources and sediment**
Direct discharge of treatment system effluent	40 CFR 125.123(b), 125.122, 125.123(d)(1), and 125.124	**Requirements and criteria including compliance with federal water quality criteria and best available technology (BAT); NPDES permit requirements**	**Direct discharge to waters of the United States; applies to sources only**

TABLE 10. Continued

Action	Citation	Requirement	Prerequisites for Applicability
Discharge to a publicly owned treatment works (POTWs)	40 CFR 403.5 40 CFR 264.71, 264.72	Requirements for discharges to POTWs	Discharge to Tacoma POTWs; applies to sources only
Land treatment	40 CFR 264.271, 264.273, 264.276, 264.278, 264.281, 264.282, 264.283	Design, monitoring, and treatment requirements	RCRA hazardous waste; applies to sources and sediment
Other treatment	42 USC 3004(d)(3), 3004(e)(3), 6924(d)(3), 6924(e)(3) 50 FR 40726 40 CFR 264 40 CFR 268 to 268.13	Proposed standards for treatment other than incineration and land treatment	RCRA hazardous waste; applies to sources and sediment
TBCs[b]			
Upland disposal of solid waste or dangerous waste	Tacoma Pierce County Health Department Regulations for Sanitary Landfills (pending)	Disposal in an approved surface impoundment	Material must be classified as solid waste; applies to sources and sediment
Dredging and disposal of dredged material	Puget Sound Dredged Disposal Analysis (1988)	Dredged material must meet chemical and biological criteria for disposal in Puget Sound	Disposal of dredged material suitable for open-water, unconfined sites in Puget Sound; applies to sediment only
	EPA Wetlands Action Plan, EPA Office of Water and Wetland Protection (January 1989)	No net loss of remaining wetlands base	Dredge and disposal of dredged material in wetlands

[a] Applicable or relevant and appropriate requirements.

[b] Other factors to be considered

9. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

CERCLA guidance (U.S. EPA 1988) requires that each remedial alternative be evaluated according to specific criteria. The purpose of the evaluation is to identify the advantages and disadvantages of each alternative, and thereby guide selection of the remedy offering the most effective and feasible means of achieving the stated cleanup objective. While the nine CERCLA evaluation criteria are all important, they are weighted differently in the decision-making process depending on whether they describe a required level of performance (threshold criteria), technical advantages and disadvantages (primary balancing criteria), or review and evaluation by other entities (modifying criteria). The 10 CB/NT candidate alternatives described in Section 8 were evaluated under CERCLA according to the following criteria:

- Threshold criteria
  - Overall protection of human health and the environment
  - Compliance with ARARs
- Primary balancing criteria
  - Long-term effectiveness and permanence
  - Reduction of toxicity, mobility, or volume through treatment
  - Short-term effectiveness
  - Implementability
  - Cost
- Modifying criteria
  - State and tribal acceptance
  - Community acceptance.

Alternatives are discussed in the relative order in which they best meet the criteria (e.g., those alternatives that most closely meet the criteria are discussed first). Following is a description of the evaluation criteria and the comparative evaluation of each candidate remedial alternative.

9.1 THRESHOLD CRITERIA

The remedial alternatives were first evaluated in relation to the threshold criteria: overall protection of human health and the environment and compliance with ARARs. The threshold criteria must be met by the candidate alternatives for further consideration as remedies for the Record of Decision.

9.1.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment requires evaluation of how well the remedy eliminates, reduces, or controls risks from each exposure pathway; whether there are unacceptable short-term or cross-media impacts; and whether exposure levels for carcinogens are brought within the acceptable risk range.

All alternatives except the no-action and institutional controls alternatives provide overall protection of human health and the environment. The no-action alternative fails to meet the stated cleanup objective throughout all problem areas because the existing threats to human health and the environment are unaltered. The institutional control alternative does not meet the threshold criteria for protection of human health and the environment in large portions of most problem areas because the exposure pathway to contaminants via ingestion of contaminated food species remains unmitigated, and adverse biological effects continue to occur for an unacceptable period of time. Because the no-action and institutional controls alternatives fail to meet threshold criteria, they were no longer considered as feasible remedial alternatives.

9.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

Compliance with ARARs requires evaluation of the remedy for compliance with chemical-, location-, and action-specific ARARs (or justification for a waiver); and whether the remedy adequately considers other criteria, advisories, and guidelines.

All alternatives except the no-action and institutional controls alternatives are able to comply with ARARs at the site. All alternatives that require dredging may require variances as authorized by the Clean Water Act allowing for temporary contaminant and turbidity levels that may occur during dredging. Such waivers may be justified on the basis that long-term site cleanup will be attained. Because the no-action and institutional controls alternatives fail to meet the intent of CERCLA and the NCP, they were no longer considered feasible remedial alternatives.

9.2 PRIMARY BALANCING CRITERIA

Once an alternative satisfies the threshold criteria, five primary balancing criteria are used to evaluate other aspects of the potential remedies. Each alternative is evaluated by each of the balancing criteria. One alternative will not necessarily receive the highest evaluation for every balancing criterion. The balancing criteria evaluation are used in refining the selection of candidate alternatives for the site. The five primary balancing criteria are: long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. Each criterion is further explained in the following sections.

9.2.1 Long-Term Effectiveness and Permanence

In evaluating long-term effectiveness and permanence, the magnitude of residual risks as well as the adequacy and reliability of controls must be examined. The three removal/treatment/upland disposal alternatives that utilize solidification, solvent extraction, and incineration have the highest degree of long-term effectiveness and permanence because they reduce the potential for future contaminant migration through destruction or immobilization of contaminants. Confined aquatic disposal and *in situ* capping also provide a high level of long-term effectiveness and permanence. Contaminated dredged material placed or covered in a subaquatic environment would isolate contaminants from the sensitive marine ecosystem. The potential for contaminant migration would also be very low because these two alternatives would maintain the same physicochemical conditions as the original material. Upland and nearshore disposal and land treatment are comparatively less effective and permanent than the alternatives named above. While engineering controls make upland disposal more secure than nearshore disposal or land treatment, all three of these alternatives have the potential for increased contaminant migration due to physicochemical changes in the dredged material during and after remediation.

9.2.2 Reduction of Toxicity, Mobility, or Volume Through Treatment

Evaluation of alternatives based on the reduction of toxicity, mobility, or volume through treatment requires analysis of the following factors: the treatment process used, the toxicity and nature of the material treated, the amount of hazardous material destroyed or treated, the irreversibility of the treatment, the type and quantity of treatment residue, and the statutory preference for treatment as a principal element.

The remedies that offer the greatest reduction of toxicity, mobility, or volume through treatment are the three removal/treatment/upland disposal alternatives. The solvent extraction alternative reduces the mobility and volume of organic contaminants by removing them from the dredged material. The solidification alternative reduces the mobility of contaminants but increases the total volume of material. Incineration of contaminated dredged material eliminates organic contamination, but sediments with significant levels of inorganic contamination may be relatively unaffected by incineration. Land treatment of dredged material reduces the toxicity of organic chemicals, but the aerobic soil conditions required for this alternative may increase the mobility of metals.

While *in situ* capping and confined aquatic disposal are not treatment alternatives and therefore do not reduce the volume, toxicity, or mobility of contaminants within the sediment matrix itself, these alternatives isolate the material from the environment. Nearshore and upland disposal alternatives also do not reduce the volume, toxicity, or mobility of contaminated sediments and may actually increase the mobility of compounds in untreated dredged material due to changes in physico-chemical conditions (e.g., redox potential).

9.2.3 Short-Term Effectiveness

Evaluation of alternatives based on short-term effectiveness requires an evaluation of the effectiveness of protection for the community and workers during remedial actions, environmental impacts during implementation, and the amount of time required for remedial action objectives to be achieved.

The remedy having the highest degree of short-term effectiveness is *in situ* capping, which results in minimal exposure to workers and the public and no resuspension of sediment. In addition, *in situ* capping can be implemented very quickly. The three removal/disposal alternatives are the next most effective in the short term, resulting in minimal community exposure, low worker exposure, and minimal resuspension of contaminated sediments. Confined aquatic disposal is the most timely of the three removal/disposal options because it can be implemented quickly, whereas nearshore and upland disposal options involve siting and construction delays. The three removal/treatment/upland disposal alternatives have still lower short-term effectiveness, resulting in moderate community and worker exposure and some resuspension of contaminated sediment. Further, these remedies would require 2-3 years for bench and pilot scale testing or facility installation. The land treatment alternative is the least effective of all remedies in the short term, resulting in moderate community and worker exposure and requiring a long treatment period to attain remedial action objectives.

9.2.4 Implementability

The implementability criterion has three factors requiring evaluation: technical feasibility, administrative feasibility, and the availability of services and materials. Technical feasibility requires an evaluation of the ability to construct and operate the technology, the reliability of the technology, the ease of undertaking additional remedial action (if necessary), and monitoring considerations. The ability to coordinate actions with other agencies is the only factor for evaluating administrative feasibility. The availability of services and materials requires evaluation of the following factors: availability of treatment, storage capacity, and disposal services; availability of necessary equipment and specialists; and availability of prospective technologies.

In situ capping is the most easily implemented remedial alternative in situations where navigational requirements do not impose depth restrictions. This option is a demonstrated technology, and equipment and methods for implementation are readily available. Further, sediment monitoring is easily implemented, operation and maintenance requirements are minimal, and multi-agency approval is feasible. Confined aquatic disposal is the next most easily implemented remedial alternative, having all of the benefits of *in situ* capping except that removal and subsequent confinement is less easily implemented. The confined aquatic disposal alternative can be implemented onsite in a manner that allows continued navigation within the waterway. The nearshore and upland disposal alternatives must address more contaminant migration pathways than the confined aquatic disposal and *in situ* capping alternatives. However, there is also more opportunity to engineer adequate control mechanisms and monitoring programs relative to the open-water alternatives. The nearshore and upland alternatives can be implemented at onsite locations (described in the feasibility study); however, because none of these locations have been specifically identified as available and approved for disposal of contaminated dredged material, they rank slightly lower.

The land treatment alternative is rated relatively low for implementability. This alternative requires extensive bench and pilot scale testing, monitoring during active treatment, and agency review for treatment facility siting and operation. Further, site availability for treatment is uncertain. The three removal/treatment/upland disposal options, which are only in the developmental or conceptual stages, are least easily implemented among all the remedial alternatives. System maintenance for these alternatives is intensive during remediation. In addition, approvals depend on pilot testing, and equipment for solidification and solvent extraction processes is either in developmental stages or unavailable. The incineration alternative is more feasible than the solvent extraction or solidification alternatives due to the current availability of incineration equipment.

9.2.5 Cost

In evaluating project costs, an estimation of capital costs, operation and maintenance costs, and present worth costs are required. The cost analysis that was conducted for each alternative in the feasibility study had several errors that resulted in underestimates of capital and monitoring costs. Major errors included underestimation of unit costs for dredging and failure to consider the excess volume of material requiring disposal due to the swelling of sediments during the disturbance of dredging operations. Revised cost estimates were developed in the Record of Decision for the four confinement options represented by the preferred alternative. In the following discussion, cost estimates developed for the feasibility study are used to compare costs among major categories of alternatives. The revised cost estimates developed for the Record of Decision are used to compare costs among confinement alternatives.

In the feasibility study, remediation costs for each problem area were developed for selected subsets of the 10 candidate alternatives. The subset of the 10 candidate alternatives considered to be applicable to a given problem area was determined on the basis of waste characteristics (e.g., solvent extraction was determined to be appropriate in areas where organic contamination was the major form of contamination) and problem area characteristics (e.g., *in situ* capping was not considered for waterways with active shipping traffic). Costs were developed for two options: 1) active remediation of all sediments exceeding the long-term cleanup objective, and 2) active remediation of sediments not predicted to recover to the long-term cleanup objective within a reasonable timeframe (i.e., 10 years). Candidate alternative costs developed in the feasibility study that are associated with Option 2 are presented for the eight problem areas addressed in this Record of Decision in Table 11. Although the feasibility study and proposed plan recommended a performance-based Record of Decision that could utilize various sediment remedial alternatives, preferred alternatives were identified for each CB/NT problem area. Specific alternatives were recommended based on a combination of problem area characteristics, schedule of source control, and tentative disposal site availability. The total estimated cost of the preferred alternatives for the eight problem areas described in this Record of Decision was approximately $17,500,000.

Feasibility study costs associated with incineration were the greatest, and exceeded costs associated with all of the confinement options by a factor of 10. Solvent extraction was the next most costly, exceeding costs associated with the confinement alternatives by a factor of 5. Solidification was the third most costly alternative, typically exceeding the confinement options costs by a factor of 2. The costs associated with land treatment were comparable to the costs associated with upland disposal, the most costly of the confinement options.

TABLE 11. COSTS ASSOCIATED WITH CANDIDATE ALTERNATIVES[a,b]
(THOUSANDS OF DOLLARS)

Problem Area	*In Situ* Capping	Confined Aquatic Disposal	Nearshore Disposal	Upland Disposal	Solidification/ Upland Disposal	Solvent Extraction/ Upland Disposal	Incineration/ Upland Disposal	Land Treatment
Head of Hylebos								
Capital	--	1,731	5,338	9,503	--	45,880	104,275	--
O&M[c]	--	376	421	572	--	551	551	--
Total	--	2,107	5,759[d]	10,075	--	46,431	104,826	--
Mouth of Hylebos								
Capital		1,773	5,597	10,013	--	48,568	110,461	--
O&M		289	336	475	--	453	453	--
Total	--	2,062[d]	5,933	10,488	--	49,021	110,914	--
Sitcum								
Capital	--	544	1,612	2,887	4,400	--	--	--
O&M	--	125	139	185	178	--	--	--
Total	--	669	1,751[d]	3,072	4,578	--	--	--
St. Paul								
Capital	672	1,341	4,234	7,568	--	36,742	83,566	6,154
O&M	1,282	218	231	352	--	335	335	222
Total	1,954[d]	1,559	4,465	7,920	--	37,077	83,901	6,376
Middle								
Capital		461	1,409	2,481	3,791	--	--	--
O&M		179	165	205	199	--	--	--
Total		640	1,574[d]	2,686	3,990	--	--	--

TABLE 11. (Continued)

Problem Area	*In Situ* Capping	Confined Aquatic Disposal	Nearshore Disposal	Upland Disposal	Solidification/ Upland Disposal	Solvent Extraction/ Upland Disposal	Incineration/ Upland Disposal	Land Treatment
Head of City								
Capital	--	3,372	10,454	18,658	28,260	--	--	--
O&M	--	485	572	869	828	--	--	--
Total	--	3,857[d]	11,026	19,527	29,088	--	--	--
Wheeler-Osgood								
Capital	111	139	321	504	--	2,377	5,337	606
O&M	252	31	31	39	--	38	38	86
Total	363	170[d]	352	543	--	2,415	5,375	692
Mouth of City[b,e]								
Capital	--	233	682	1,174	--	5,726	12,992	--
O&M	--	53	51	70	--	67	67	--
Total	--	286	733	1,244	--	5,793	13,059	--

[a] Reference: Tetra Tech (1988a).

[b] 10 year natural recovery included in alternative.

[c] O&M = Operation and maintenance.

[d] Preferred alternatives in CB/NT feasibility study.

[e] Institutional controls: capital cost 6, O&M 345, total 351.

Revised costs associated with the four major confinement options were developed for this Record of Decision and are summarized in Table 12. The rationale for revisions to the costs developed in the feasibility study are provided in Section 10.4. As described in Section 11.3, the confined aquatic disposal option is most likely to be implemented on an areawide basis due to site availability considerations. Therefore, it is the only option for which areawide costs are presented in Table 13. The revised areawide cost estimate for sediment remediation associated with each of the eight problem areas addressed in this Record of Decision is approximately $32,300,000, assuming the use of *in situ* capping at the St. Paul Waterway and confined aquatic disposal in the remaining seven problem areas. The costs of the other confinement options are presented as a factor of the confined aquatic disposal costs (i.e., alternative cost/confined aquatic disposal cost). The upland disposal alternative, as noted in the evaluation of feasibility study costs, is the most costly of the confinement alternatives. However, the total range in costs estimated for all four confinement options is never greater than a factor of 7, and is more typically a factor of 4 for the different problem areas. Costs associated with *in situ* capping and nearshore disposal are the lowest. The low costs associated with nearshore disposal are explained in Section 10.4 as a component of planned construction projects that require fill material.

9.3 MODIFYING CRITERIA

The modifying criteria are used in the final evaluation of remedial alternatives. The two modifying criteria are state and tribal acceptance and community acceptance. For both of these elements, the factors considered in the evaluation are the elements of the alternative which are supported, the elements of the alternative which are not supported, and the elements of the alternative that have strong opposition. Under CERCLA, tribes are provided substantially the same opportunities for project oversight and implementation as those afforded to states. At present, the opportunity for CERCLA oversight by tribes is often limited by environmental program capability and experience relative to state programs. In the case of the CB/NT project, the state is afforded co-lead status with EPA, whereas the Puyallup Tribe is currently afforded status as a supporting agency, as described in Sections 3.4 and 5.1.

9.3.1 State and Tribal Acceptance

State and tribal acceptance is addressed in the Record of Decision rather than in the CB/NT feasibility study because of their changing roles in the project during the public comment period.

As indicated previously, Ecology was the lead management agency for the CB/NT project under a cooperative agreement with EPA throughout the study phase, including the remedial investigation, feasibility study, and public comment period. State acceptance during that period was based on their role as lead management agency. Ecology was instrumental in developing the five key elements of the selected remedy. Planning schedules for integrated project implementation were jointly prepared by Ecology and EPA. During the public comment period, Ecology requested that EPA assume the lead for developing the Record of Decision due to resource constraints. However, Ecology has continued to play a key role in the development of the Record of Decision.

Continued state acceptance of the selected remedy is based on two factors. First, the selected remedy is designed to be as consistent as possible with emerging state regulations regarding the management of contaminated sediments. Second, Ecology has been established as the lead oversight agency for Operable Unit 05 (Source Control), the first and most critical step in overall project implementation. During Record of Decision development the state stressed the need to clarify several project implementation issues. For example, the process by which EPA and Ecology will determine the levels of source control which trigger the initiation of sediment remedial design and sediment remedial action in each problem area was raised as an important issue. Discussions prompted clarification and adjustments to the overall project schedule. State acceptance of the selected remedy is evidenced by a letter of concurrence in Appendix A.

TABLE 12. ESTIMATED COSTS FOR THE FOUR CONFINEMENT OPTIONS[a] (THOUSANDS OF DOLLARS)

	Waterway							
Alternative	Head of Hylebos	Mouth of Hylebos	Sitcum	St. Paul	Middle	Head of City	Wheeler-Osgood	Mouth of City[b]
Volume (yd^3)	217,000	231,000	66,000	174,000	57,000	426,000	11,000	--
In-Waterway Confined Aquatic Disposal								
Containment cost	4,840	3,300	1,950	--	2,670	5,110	967	--
Monitoring cost (annual)	222	162	93	--	76	144	12	11.7
Total cost[c]	8,140	5,710	3,360	--	4,150	7,630	1,360	107
Cost normalized to confined aquatic disposal[d]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
***In Situ* Capping**								
Containment cost	--	--	--	1,200	--	--	--	--
Monitoring cost (annual)	--	--	--	27	--	--	--	--
Total cost[c]	--	--	--	1,820	--	--	--	--
Cost normalized to confined aquatic disposal[d]	0.61	0.56	0.58	0.45	0.49	0.50	0.66	1.0
Nearshore Disposal								
Cost normalized to confined aquatic disposal[d]	0.71	0.87	0.79	0.83	0.64	0.92	1.3	1.0
Upland Disposal								
Cost normalized to confined aquatic disposal[d]	1.9	2.7	1.5	2.8	1.8	3.2	1.6	1.0

TOTAL AREAWIDE COST: 32,300[e]

TABLE 12. (Continued)

---

[a] All alternatives incorporate natural recovery. See Sections 10.4 and 11.3 for further explanations and assumptions.

[b] Costs for Mouth of City Waterway represent monitoring costs only.

[c] Contingency - 20%
Administration - 8%
Discount rate - 7%
Includes monitoring over 10 years.

[d] Presented as a factor of confined aquatic disposal costs $\left(\frac{\text{indicated alternative}}{\text{confined aquatic disposal}}\right)$

[e] Combines *in situ* capping cost for St. Paul with in-waterway confined aquatic disposal for remaining seven problem areas.

Acceptance by the Puyallup Tribe has also changed over the duration of the project. Through most of the remedial investigation and feasibility study the tribe provided comments on the project as a member of the Technical Oversight Committee. The tribe's comments on draft documents and their feedback in meetings were primarily concerned with the need to adequately address chronic effects in the marine environment and to ensure protection of fisheries resources. As a supporting agency for continued project management, the tribe has continued to express concern about the permanence and effectiveness of the selected remedy. Many tribal members rely on subsistence fishing in Commencement Bay and contaminants such as PCBs and dioxins are of particular concern because of their toxicity, persistence, and tendency to bioaccumulate in the marine environment. Although the tribe has expressed concern about the impact of hazardous substances on fisheries resources and human health, the Puyallup Environmental Commission regards the selected remedy as an important means of mitigating and preventing those impacts. Tribal acceptance of the selected remedy is evidenced by a letter of concurrence (Appendix A) which expresses both support for the remedy and concerns that it may be difficult to implement in a manner that will be fully protective. The Puyallup Tribe's concerns may be addressed through continued participation in the enforcement activities outlined in Section 3.

9.3.2 Community Acceptance

The agencies have carefully considered all comments submitted during the public comment period and have taken them into account during the selection of the remedy for the CB/NT project as described in this Record of Decision. Based on the comments received during the public comment period, members of the community are supportive of the overall approach that combines source control, natural recovery, and sediment remediation (if necessary). Most commenters agreed that there are demonstrable adverse environmental impacts in the CB/NT sediments, that the area should support a multiplicity of uses (e.g., commercial, recreational), and that source control should be a high priority.

Commenters expressed numerous divergent opinions on several key issues. These included the environmental and human health risks posed by the site, the proposed cleanup goals, the feasibility of and timeframe for source control, and the protectiveness and proposed role of natural recovery as a component of the remedy. For example, some commenters said that there is no significant human health risk, while others argued that the human health risk is far greater than the feasibility study estimate. These various divergent comments have been considered in the selection of the remedy and responded to in the Responsiveness Summary (see Appendix B).

Some commenters offered new information which led the agencies to modify the selected remedy from the proposed plan. The Puyallup Tribe of Indians and the National Oceanic and Atmospheric Administration raised significant habitat preservation and fisheries enhancement issues that resulted in the agencies giving these issues additional weight in the remedy. Most commenters believed that the estimates for feasible source control and the time necessary to achieve source control were overly optimistic. These estimates have been revised. Remedial costs and volume estimates were challenged, and upon review, the agencies have revised these estimates upward. ASARCO provided new information about the sediments along the Ruston-Pt. Defiance Shoreline which resulted in that problem area being separated into a new operable unit.

9.4 OVERALL RANKING

The confinement alternatives (3, 4, 5, and 6) represent the most effective and feasible means of achieving overall protection of human health and the environment at the CB/NT site. This high overall ranking for confinement alternatives is a reflection of the general characteristics of problem sediments at the eight CB/NT problem areas addressed here. CB/NT sediments are characterized by relatively low concentrations of contaminants which often have a high affinity for sediment particles, and the total volume of sediments requiring active remediation is large (i.e., greater than 1 million cubic yards as estimated in the feasibility study). Confinement of CB/NT sediments therefore offers the most appropriate and cost-effective means of achieving the cleanup objectives for this site.

All confinement alternatives can be implemented at the CB/NT site, minimizing the costs and risks of transporting contaminated sediments to distant locations. Onsite disposal is also more acceptable under Superfund policy and guidance than the offsite disposal of untreated waste materials. In addition, performance monitoring for all confinement options uses well established sampling and analytical methods. Given appropriate siting conditions, the *in situ* capping alternative can be most readily implemented, and because it does not involve dredging of contaminated sediments, eliminates potential problems associated with contaminant redistribution during sediment resuspension. Both *in situ* capping and in-waterway confined disposal alternatives have the added advantage of preserving the original physicochemical conditions, which limits the potential for contaminant mobilization associated with the transition from anaerobic to aerobic conditions. However, in environments with a high potential for ship scour, currents, and wave action, these two alternatives are more susceptible to disruption of the cap, and added protective measures need to be incorporated into the design characteristics to ensure permanence. For example, in navigable waterways the confined aquatic disposal alternative must be implemented so that the top of the cap neither impedes shipping traffic, nor is susceptible to ship scour. Over-dredging to such a depth may require the placement of a significant amount of clean dredged material out of the waterway to accommodate some bulking of contaminated sediments at the disposal site.

In contrast, implementability of nearshore and upland disposal is much more dependent on the availability of limited disposal sites. Potential loss of intertidal and wetland habitat is an important consideration in both cases. However, nearshore disposal can proceed rapidly and be cost-effective when the disposal facility is developed in conjunction with authorized shoreline development projects (e.g., fill operations). Habitat mitigation will be a key component of such projects as required by Section 404 of the Clean Water Act. Upland disposal is also a viable option that can be incorporated into property development projects or implemented on some of the remaining vacant land in the study area.

Aerobic conditions at nearshore and upland facilities may enhance contaminant mobility; however, a greater degree of control in the design, construction, and maintenance of the confinement system is possible. While contamination of groundwater is more likely in the event of failure at an upland disposal facility, adequate engineering and monitoring can be developed to control contaminant migration. Transport of contaminated sediment to the upland facility would also pose additional worker and public exposure hazard in the event of a spill. Loss of intertidal habitat is an important disadvantage associated with nearshore disposal.

In general, all of the treatment alternatives are more effective than the confinement alternatives at reducing the toxicity, mobility, and volume of contamination; however, in most cases available treatment technologies are not appropriate to the chemical mixtures (i.e., mixed metals and organic compounds) that characterize contaminated sediments at the CB/NT site. The greater permanence of the treatment alternatives relative to the confinement alternatives does not justify the increased cost of treating sediments at the CB/NT site. CB/NT problem sediments are relatively low concentration/high volume wastes for which treatment is not considered appropriate or cost-effective under Superfund. In addition, these alternatives are not as readily implemented as the confinement alternatives, in some cases requiring 2-3 years of pilot tests, and therefore offering less certainty in terms of long-term protection and less capability of mitigating significant threats to human health and the environment in the short-term.

10. SELECTED REMEDY

Based upon consideration of the requirements of CERCLA and the NCP, the detailed analysis of the alternatives, and public comments, EPA, the state of Washington, and the Puyallup Tribe have determined that Source Control/Natural Recovery/Sediment Confinement is the most appropriate remedy for achieving the CB/NT cleanup objectives. The selected remedy represents a generalized form of Candidate Alternatives 3, 4, 5, and 6 by incorporating all four options for confinement of contaminated sediments: in-place capping, confined aquatic disposal, nearshore disposal, and upland disposal. The selected remedy is also represented by a specific combination of the key elements described in Section 8.2: site use restrictions, source control, natural recovery, sediment remedial action, and monitoring. It is expected that the selected remedy will be protective of public health and the environment, and will meet federal, state, and tribal ARARs. The project objectives are to be achieved in a 15-20 year period by implementing these key elements in an interdependent, integrated fashion. In general, however, because of differences regarding location, environmental characteristics, and status of source control between problem areas, the selected remedy will be implemented independently in each of the eight CB/NT problem areas.

A remedy utilizing a generalized sediment remediation element was selected because all four confinement options provide an effective means of protecting human health and the environment at the CB/NT site. They are also comparable in terms of overall feasibility and cost-effectiveness. By allowing the flexibility to utilize any one or combinations of the four confinement options in each problem area, the selected remedy maintains the greatest degree of consistency with the intent of the 1989 PSWQA plan (PSWQA 1988; Element S-4, Sediment Disposal Standards). It also offers the best opportunity to implement the remedy in a timely manner while integrating the following factors when appropriate:

- **Construction or development projects within the waterways**
- **New information gained during the remedial design phase**
- Newly available disposal sites.

10.1 CLEANUP OBJECTIVES

The objective of the selected remedy is to achieve acceptable sediment quality in a reasonable timeframe. This objective has been defined in terms of biological and chemical tests, as described in Section 7 and summarized in Section 8.1. As described in Section 8.2, sampling and test evaluation protocols for environmental effects, as well as the AET database, are to remain consistent with any adjustments adopted by the Puget Sound Estuary Program. Because the objective of the selected remedy is to achieve the sediment quality goal in a reasonable timeframe, natural recovery is integrated into the overall remedy. Natural recovery considerations are used to identify sediment remedial action levels that delineate sediments that are allowed to recover naturally from those that require active sediment cleanup. The sediment quality objective also applies to source control requirements. Monitoring of sources and sediments will be used to determine the effectiveness of source controls. Habitat function and enhancement of fisheries resources will also be incorporated as part of the overall project cleanup objectives. For example, the physical characteristics and placement of material used for capping contaminated sediments in the marine environment will be required to provide a suitable substrate and habitat for aquatic organisms that may utilize that environment.

10.2 KEY ELEMENTS OF THE SELECTED REMEDY

The selected remedy includes the following major elements:

- Site use restrictions
- Source control
- Natural recovery
- Sediment remedial action (i.e., confinement and habitat restoration)
- Monitoring.

10.2.1 Site Use Restrictions

Site use restrictions consist mainly of public warnings and educational programs intended to reduce potential exposure to site contamination, particularly ingestion of contaminated seafood. Local health advisories are an integral part of the overall remedy because the ultimate objective will be achieved over a 15-20 year period.

10.2.2 Source Control

The general characteristics of source control at the CB/NT site are described in Section 8.2.2. Implementation schedules for source control activities in the eight high priority problem areas addressed in this Record of Decision are summarized in Appendix C.

The success of source control is evaluated using monitoring data, typically collected as part of permit requirements. In addition to existing source control programs, Ecology is developing several source-related regulations and requirements to be implemented statewide. Ecology requirements that are specific to Puget Sound, and which may be integrated into source control activities, include the following:

- Standards for identifying and designating sediments that have acute or chronic adverse effects on biological resources or that pose a significant health risk to humans
- Definitions of acceptable source control technologies (i.e., AKARTs) for various types of sources (e.g., pulp mills, sewage treatment plants, shipyards, storm drains)
- Administrative rules for establishing receiving water and sediment dilution zones in the vicinity of wastewater discharges (the sediment dilution zone is commonly referred to as a sediment impact zone, a specific area adjacent to a municipal or industrial discharge where sediment standards are relaxed by permit; sediment impact zones may be established when technical feasibility, time, or cost limits the ability of a discharger to comply with sediment standards)
- Administrative rules for establishing sediment recovery zones in the vicinity of wastewater discharges (a sediment recovery zone is a variance for cleanup actions to allow consideration of time, cost, and technical feasibility in meeting sediment standards)
- Guidelines for determining when the concentration or loading rate of chemical contaminants discharged from a source could exceed sediment standards
- Chemical-specific concentrations or loading limits for source permits based on AKARTs.

As the regulations and requirements are being developed, Ecology's Sediment Management Unit staff have periodically outlined how they will be implemented. Effluent limitations will be derived for those contaminants remaining in an effluent stream after applying AKARTs. Permit requirements will be used initially to address effluent and treatment system analyses when sediment quality is determined to violate interim sediment quality values, or final sediment quality standards, when adopted. Sediment quality standards (or interim values) will not explicitly be used to derive effluent limits, but they will be considered in the selection of appropriate treatment technologies. A sediment impact and/or recovery zone, which may be based initially on standardized size constraints, may be established when treatment technology is inadequate. Results from monitoring effluent and sediments will be used as feedback to technology requirements during permit renewals and modifications. If monitoring reveals problems in meeting receiving water quality standards, sediment quality standards, or permit requirements, then the adequacy of AKARTs will be re-evaluated, technology more stringent then AKARTs may be considered, beyond-pipe maintenance may be required, or the sediment impact zone and/or recovery zone size may be altered.

10.2.3 Natural Recovery

Natural recovery of some or all of a given problem area may occur through chemical degradation, diffusive losses across the sediment-water interface, and burial and mixing of contaminated surface sediments with recently deposited clean sediments. Areas that are expected to recover naturally within 10 years of sediment remedial action (based on modeling results confirmed by monitoring data) are initially exempt from sediment remedial action (i.e., confined disposal). However, monitoring to confirm the long-term effectiveness of the recovery will be required as part of the overall CB/NT selected remedy. Should subsequent monitoring data indicate that natural recovery is not viable in a reasonable timeframe, the need for active sediment remediation may be reconsidered. Areas that are predicted to recover naturally are defined by the following performance criteria for priority problem chemicals particular to each problem area, as described in the feasibility study:

- **Minimum Chemical Concentration:** Surface sediment concentrations exceed the long-term cleanup objective (illustrated for indicator chemicals in Table 13)
- **Maximum Chemical Concentration:** Surface sediment concentration are less than sediment remedial action cleanup levels (illustrated for indicator chemicals in Table 13).

The recovery factor is derived from a mathematical model, SEDCAM, that relates recovery rate to source loading, sedimentation rate, surface sediment mixing due to bioturbation and physical disturbance, and existing levels of contamination (Tetra Tech 1988a). Recovery factors developed in the feasibility study for selected indicator chemicals are summarized in Table 13. These recovery factors will be modified on the basis of source loading and sediment data collected during remedial design.

10.2.4 Sediment Remedial Action

The estimated surface areas and sediment volumes in the CB/NT problem areas that are subject to sediment remedial action are summarized in Table 14. These areas and volumes are reduced from the areas and volumes that exceed sediment quality objectives on the basis of recovery factors developed during the feasibility study. These areas and volumes will be revised on the basis of sediment sampling during remedial design. Tentative implementation schedules for sediment remedial action are summarized in Appendix C. These schedules are highly dependent upon the successful implementation of source control actions.

Results of sediment sampling during the remedial design phase will be used to refine estimates of the areal extent and depth of contamination to be addressed by the sediment remedial alternative. These data will also be used to identify temporal changes in problem chemical concentrations resulting from sedimentation and from source control actions that occurred after the remedial investigation/feasibility study sampling phase. Documented changes then will be used to refine

TABLE 13. INDICATOR CHEMICALS AND RECOVERY FACTORS

Problem Area	Indicator Chemical	Sediment Quality Objective[a]	10-year Recovery Factor[b]	Remedial Action Level[a,c]
Head of Hylebos	PCBs	150	1.6	240
	Arsenic	57	1.7	97
	HPAH	17,000	1.9	32,000
Mouth of Hylebos	PCBs	150	2.0	300
	Hexachlorobenzene	22	4.6	100
Sitcum	Copper	390	2.9	1,100
	Arsenic	57	2.9	160
St. Paul	4-Methylphenol	670	1.9	1,300
Middle	Mercury	0.59	1.2	0.71
	Copper	390	1.2	470
Head of City	HPAH	17,000	1.3	22,000
	Cadmium	5.1	1.3	6.6
	Lead	450	1.3	580
	Mercury	0.59	1.3	0.77
Wheeler-Osgood	HPAH	17,000	1.2	20,000
	Zinc	0.59	1.2	490
Mouth of City	HPAH	17,000	1.5	25,000
	Mercury	0.59	1.5	0.89

[a] Concentration, expressed as μg/kg dry weight for organics and mg/kg dry weight for metals.

[b] Maximum enrichment ratio (i.e., observed concentration/cleanup objective) in surface sediment that will recover (i.e., return to 1.0) in 10 years.

[c] Target cleanup levels will change based on source monitoring and sediment remedial design data.

TABLE 14. ESTIMATED SURFACE AREAS AND VOLUMES OF SEDIMENTS SUBJECT TO SEDIMENT REMEDIAL ACTION[a]

Waterway	Area	Volume
Head of Hylebos	217	217
Mouth of Hylebos	115	230
Sitcum	66[b]	66[b]
St. Paul	87	174
Middle	114	57
Head of City	171	426
Wheeler-Osgood	22	11
Mouth of City.	0	0
TOTAL	792	1,181

[a] Areas are reported in units of 1,000 square yards. Volumes are reported in units of 1,000 cubic yards.

[b] Includes sediment for which biological effects were observed for nonindicator compounds.

predictions of the rate of problem area recovery (i.e., to develop refined recovery factors) and to re-evaluate the need to implement sediment remedial action. In addition, sediment sampling conducted during remedial design will provide a baseline assessment for subsequent monitoring to determine the success of remedial action. Guidelines for developing source monitoring and sediment remedial design sampling programs are provided in the integrated action plan (PTI 1988).

Habitat mitigation and fisheries enhancement projects will also be incorporated into sediment remedial actions. The scope and focus of these activities will be determined on a site specific basis during remedial design. For example, the habitat restoration protocols being developed by EPA's Region 10 Wetlands Program and Puget Sound Estuarine Program will be incorporated into the evaluation and design process.

In the following sections, the general characteristics of the four confinement options that constitute the sediment remedial action element of the selected remedy are described in terms of the factors that may influence their selection for all or a portion of the problem area. The choice of confinement option ultimately applied to a site will depend on the results of the remedial design phase, the status of available remedial technologies evaluated during remedial design, and availability of disposal sites. These confinement options are described in greater detail in Section 8.3 and in the feasibility study. The ultimate selection of a specific confinement option or combination of confinement options for a particular problem area will also be affected by economic and development considerations.

In-Place Capping—*In situ* capping involves containment and isolation of contaminated sediments through placement of clean material on top of existing substrate. In-place capping is inappropriate for environments with a high potential for ship scour, current action, or wave action because these disturbances can lead to cap erosion. Currents in the CB/NT problem areas are primarily tidal in origin and result in generally quiescent flow conditions. Maintenance dredging precludes the use of capping in areas maintained for shipping navigation. Capping of sediment with high concentrations of unstable organic matter may result in methane formation which can produce bubbles and may potentially disrupt the cap as they float to the surface. The effect of this process on cap integrity and contaminant migration should be evaluated in pilot studies. The primary environmental impacts associated with implementation of this alternative is loss of existing benthic and intertidal habitat at the site. Because of the high value placed on intertidal habitat, any loss of intertidal habitat would require corresponding habitat mitigation.

In-place capping may be determined appropriate during remedial design for those portions of a problem area that are not subject to shipping traffic, or where shipping traffic could be restricted. This alternative could also be included as a partial site remedy if remedial design results suggest that it is appropriate to consolidate sediments and restrict navigation in a portion of the waterway.

In-place capping has been selected as the confinement option appropriate to St. Paul Waterway. As described in Section 6.4, the Simpson Tacoma Kraft Company, in cooperation with Ecology, designed and implemented the capping operation that began in December 1987 and ended in September 1988. The capping project was coordinated with related remedial actions, including dredging for outfall alignment, placement of material dredged from the outfall, dredging along the chip unloading dock and the new chip unloading facility, and intertidal habitat enhancement. Future EPA enforcement actions will expand response actions (e.g., sediment monitoring activities) at this problem area.

Confined Aquatic Disposal—Confined aquatic disposal involves the subaquatic disposal and capping of contaminated sediments. The hydraulic energy associated with the quiescent waterways in the CB/NT problem areas is lower than in other shallow-water environments exposed to more direct wave action. However, propeller wash and ship scour would be expected to significantly increase subsurface energy in the shallow-water environment. If sited in shallow water, the disposal site should be located in an area that would not be dredged, and where shipping traffic could be restricted. If sited in an active shipping area where future dredging is expected, the contaminated dredged material and cap must be placed deep enough to preclude cap disruption associated with prop wash and dredging activities. Details of in-waterway confined aquatic disposal are described in the feasibility study (Tetra Tech 1988a) and Phillips et al. (1985).

Nearshore Disposal—Nearshore disposal involves dredging of contaminated sediments followed by confined disposal in the nearshore environment. The primary environmental impact associated with implementation of this alternative is loss of existing benthic and intertidal habitat at both the dredge and disposal sites. Because of the intertidal location of the disposal site and the high value placed on intertidal habitat, this alternative would require a habitat mitigation component. As a general policy for the CB/NT site, EPA would prefer that the nearshore disposal option only be utilized in conjunction with projects that would otherwise be permitted commercial development. The intent of this policy is to minimize unnecessary impact to nearshore habitat, consistent with the provisions of Clean Water Act Section 404. Also, the influence of tides and groundwater on contaminant transport would be much greater for nearshore confinement than for confined aquatic disposal or upland disposal. In addition, altered redox conditions may increase the mobility of metals, depending upon the level of placement within the disposal site. To the maximum extent practical, sediments containing predominantly inorganic contaminants would be placed below the water table level in the confinement facility to minimize contaminant mobility. Nearshore confinement may be determined appropriate during remedial design for a problem area if it can effectively be integrated into an ongoing construction and fill project.

Upland Disposal—Dredging followed by upland disposal onsite would involve the transfer of contaminated dredged material to a confinement facility that is not tidally influenced. The primary environmental impact of this remedial alternative would be destruction of the existing benthic and intertidal habitat at the dredging site. As with all alternatives that involve dredging, resuspension of contaminated sediment would also be a concern. Destruction of habitat at the upland disposal site is likely to be less significant than at a nearshore site. However, implementation of this alternative would involve risks to area groundwater resources in the event of contaminant leakage from the containment facility. Transport of contaminated dredged material to the upland facility would also pose additional worker and public exposure hazards in the event of system failure or spill. Disposal in an upland facility would result in significant physicochemical changes in dredged material that could increase mobility of metal and organic contaminants.

10.2.5 Monitoring

Source monitoring and sediment remedial design sampling and monitoring play a key role in the refinement of the remedial alternative, because for many problem areas the data analyzed in the remedial investigation and feasibility study were not adequate to 1) fully determine the effectiveness of source controls implemented to date, or 2) define the volume of sediment exceeding the cleanup objective with a high degree of confidence. Furthermore, several source control actions have been implemented since the source loading analysis was conducted. Data gaps associated with sources will be addressed by the source control programs that are directed by Ecology. Source monitoring data will be developed to characterize the discharge or release, the receiving body of water, and associated sediments, according to both chemical and biological parameters. Source loading data (i.e., measurements of the amount of contaminant discharged to the various problem areas) provide the most important information for determining the effectiveness of source controls, the relative contributions of problem chemicals by ongoing sources, and the need for additional source controls.

Monitoring during sediment remedial design can be used to assess CB/NT feasibility study predictions of the rate of natural recovery of a problem area and the estimated cleanup volume. For example, if a problem area was predicted to have a very slow rate of natural recovery, but results of the remedial design sampling indicate that the volume of sediment exceeding cleanup goals had decreased significantly since the CB/NT feasibility study and remedial investigation sampling, the decision to implement sediment remedial action may be re-evaluated. Similarly, if a significantly slower rate of recovery is documented in areas predicted to recover naturally within a reasonable time, sediment remediation may be required, rather than reliance on natural recovery. Additional monitoring may be advisable depending on the time lapse before implementation of the sediment remedial alternative. Sediment monitoring will be required during sediment remedial action to establish a baseline from which to evaluate the effect of source control and natural recovery in areas where natural recovery is predicted to be a viable means of achieving the project cleanup objectives.

Monitoring within problem areas, at disposal sites, and at habitat mitigation/restoration areas developed as part of the sediment remedial action within CB/NT problem areas will be conducted to evaluate the effectiveness of the remedy in achieving the sediment quality objectives and in relation to habitat function, especially relative to fisheries resources. Sediment monitoring will be used to develop data for priority problem chemicals within each problem area as described in the feasibility study and other chemicals that may become of concern to EPA through source monitoring or other related studies. Biological effects data may also be developed at the option of the PRPs or the agencies to confirm problem area characteristics relative to the sediment quality objectives. Habitat evaluation will be conducted in accordance with habitat restoration protocols that are currently being developed by EPA's Region 10 Wetlands Program and Puget Sound Estuary Program. These protocols will be incorporated into habitat evaluation in the CB/NT problem areas before and after sediment remedial action at both dredging and disposal sites. These protocols are being designed to quantitatively assess the characteristics of an area that contribute to habitat function (i.e., feeding, refuge, and reproduction).

10.3 IMPLEMENTATION

Source identification, characterization, and control activities are underway in all eight problem areas. In general, the remedial alternatives selected for the different problem areas will be implemented independently of one another. For the St. Paul Waterway, source control and sediment remedial action implemented under a state consent decree were completed in September 1988. The success of these actions is being evaluated through a monitoring program, which is to be expanded by EPA to ensure consistency with this Record of Decision and long-term protectiveness of the action. In the remaining seven problem areas, key elements of the selected alternative will be conducted together or in sequence over a 15-20 year period. Implementation schedules for source control and sediment remedial activities for all eight problem areas have been developed for planning purposes, and are provided in Appendix C. The timing of source control actions is highly dependent on the availability of agency staff and financial resources, the success of negotiations with PRPs, and the results of source investigation and control actions.

The successful implementation of the selected remedy requires that the key elements of this Record of Decision be carried out in an integrated, interdependent fashion within each problem area. Relationships among the key decision points and key elements of the selected remedy are illustrated in Figure 18.

After signature of the Record of Decision, Ecology will continue to identify CB/NT sources and enforce appropriate source control measures, and enforce those measures. Source monitoring will be required by Ecology to evaluate the effectiveness of source control measures. Ecology and EPA will evaluate the source monitoring data to determine when source control is sufficient to begin the remedial design phase for sediment remedial action in each problem area. Several factors will be considered in this evaluation, including the possibility of unidentified major sources within the problem area, the status of source control for known major sources, and the possible cumulative effects from other CB/NT sources.

For each problem area, the remedial design phase will begin with sediment sampling to refine the volume estimate of contaminated sediments exceeding the sediment quality objective and the predicted natural recovery rate. This sampling data will be used by EPA to determine whether the problem area, or portions thereof, will achieve sediment quality objectives through natural recovery

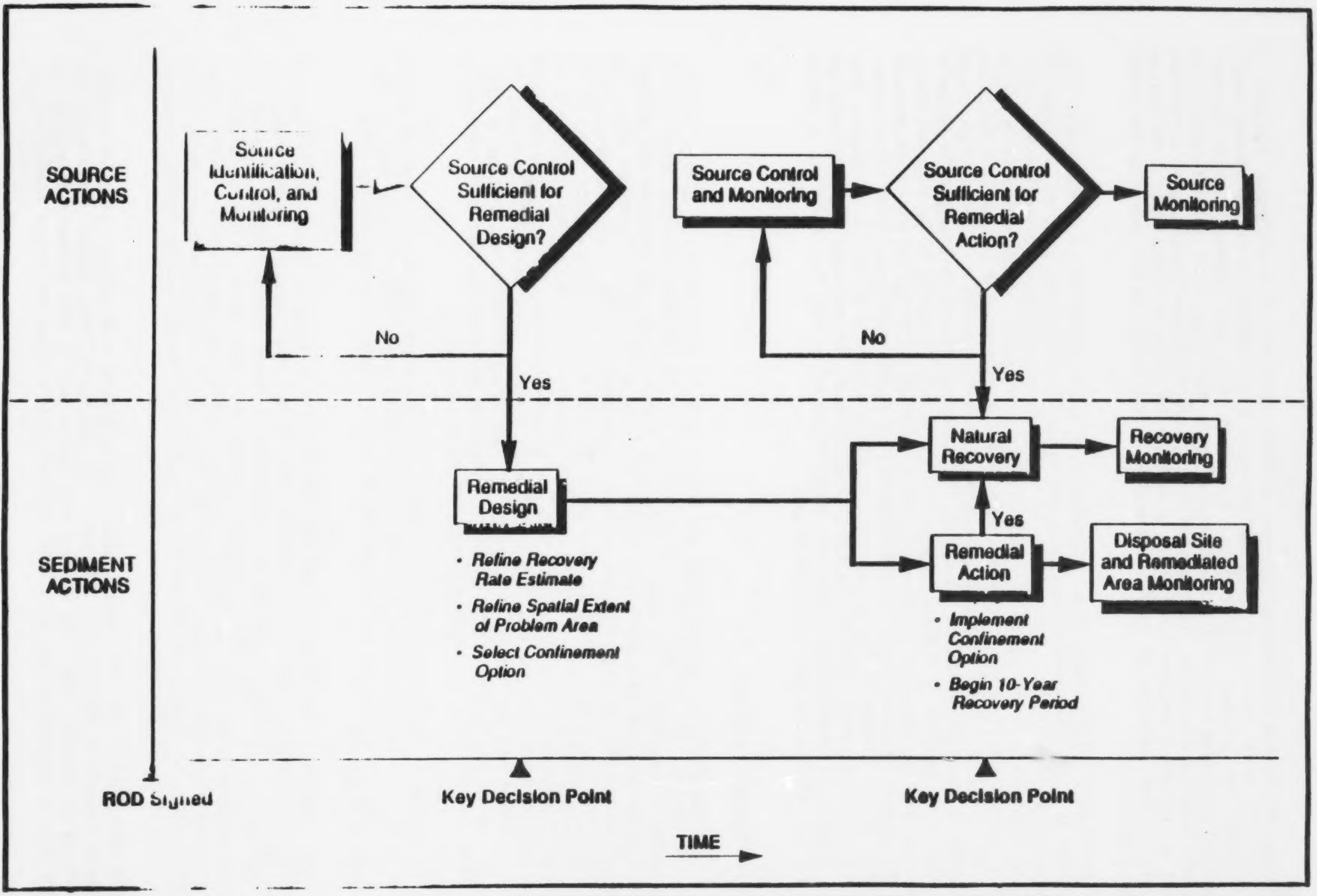

SOURCE ACTIONS
SEDIMENT ACTIONS
Source Identification, Control, and Monitoring
Source Control Sufficient for Remedial Design?
No
Yes
Remedial Design
• Refine Recovery Rate Estimate
• Refine Spatial Extent of Problem Area
• Select Confinement Option
Source Control and Monitoring
Source Control Sufficient for Remedial Action?
Source Monitoring
No
Yes
Natural Recovery
Recovery Monitoring
Yes
Remedial Action
Disposal Site and Remediated Area Monitoring
• Implement Confinement Option
• Begin 10-Year Recovery Period
ROD Signed
Key Decision Point
Key Decision Point
TIME

Figure 18. Key decision points and associated activities

]

in a reasonable timeframe (i.e., 10 years), or whether sediment remedial action is necessary in all or a portion of the problem area. This information will also be used to support the selection of the appropriate confinement option or combination of confinement options if remedial action is determined to be necessary for a particular problem area.

New information on previously unidentified contaminants will also be evaluated during the remedial design phase and integrated into the remedial design sampling and analysis strategy. For example, recent sampling conducted by EPA as a part of a national bioaccumulation study has indicated that dioxin may be present in shellfish in the CB/NT site at levels that pose a potential threat to human health (Appendix B, Section 2.1.6). Preliminary evaluation of this data suggests that further development of source- and sediment-related dioxin data in the Hylebos and St. Paul Waterways is warranted.

Following remedial design, source control and monitoring will continue until Ecology and EPA determine that all major sources have been controlled to the extent that sediment recontamination is not predicted to occur or the source is in compliance with AKARTs. Sediment remedial actions will then be implemented, including sediment monitoring to establish a baseline from which the 10-year recovery period will be evaluated for all areas predicted to recover naturally.

There may be facilities or storm drains which, after implementation of AKARTs, still contribute contaminants at levels that will exceed sediment cleanup objectives in the vicinity of the source. For these facilities, a waiver may be incorporated into applicable permits to allow a temporary sediment impact zone. However, this will not delay or alter implementation of the selected remedy, and sediments within a permitted impact zone will be subject to the same remedy selected in this Record of Decision (i.e., recovery or confinement). Source monitoring will continue under Ecology's source control program. Post-remedial action source monitoring will also ensure that source controls remain effective and that new contaminants are not being introduced.

As part of the sediment cleanup action, EPA will develop and implement monitoring programs for areas that are predicted to recover naturally, areas that have undergone sediment remediation, and for disposal sites. Sediment monitoring will confirm that the selected remedy is effective by 1) tracking the progress of natural recovery, 2) managing permitted sediment impact zones, 3) confirming the effectiveness and integrity of sediment confinement options, and 4) ensuring that source controls remain effective and that new contaminants are not being introduced.

10.4 COSTS

Costs associated with source control activities are not included in this Record of Decision, but may be developed as part of the individual source control actions enforced by Ecology. Because source-related activities are being enforced largely according to existing environmental programs at the federal, state, and local levels, and because the scope of these activities typically goes beyond the identification and control of contaminant loading to the marine environment, it is difficult to determine what proportion of total source-related cost can be attributed to mitigation of contaminated sediments. It is even more difficult to determine the incremental cost of source control that is directly attributable to achieving CB/NT project objectives, relative to achieving compliance with non-CERCLA source control requirements.

Estimated costs associated with sediment-related actions are summarized in Table 12. Revised confined disposal cost assumptions were developed for this Record of Decision, summarized below, and detailed in Appendix D. Costs are modified from the estimates provided in the CB/NT feasibility study based on new information received during and after the public comment period and additional discussions with dredging vendors. Costs associated with confined aquatic disposal are dependent on the sediment volume estimates developed from available sediment data and the natural recovery factors that were incorporated into sediment remedial action cleanup levels to achieve sediment quality objectives within 10 years. Sediment cleanup volume estimates will be refined during the remedial design phase and costs are anticipated to change accordingly.

Costs are also affected by engineering considerations that cannot be fully evaluated until remedial design is completed. The cost estimates presented in Table 12 are based on volume estimates for sediments that are not predicted to recover to the sediment quality objectives in a reasonable timeframe (i.e., 10 years). Other assumptions are:

- The sediment volume to be dredged is composed of a whole number of 4-foot dredging lifts. This assumption incorporates an overdredging allowance.
- Dredged material swells by 75 percent as a result of water entrainment. Upon redeposition, compaction will reduce the volume to an amount only 20 percent greater than the initial volume.
- Excess volume generated by swelling of overdredged sediments at in-waterway confined aquatic disposal sites is disposed of at the PSDDA site. This material is assumed to be clean, as it originates from below the contaminated sediments.
- Sufficient Puyallup River sediment is available to carry out habitat mitigation for the nearshore disposal alternative.
- As a general policy for the CB/NT site, EPA would prefer that the nearshore disposal option only be utilized in conjunction with projects that would otherwise be permitted commercial development. Site preparation costs are to be assumed by the developer and are not included in these estimates. For the purpose of estimating transportation costs, the Blair Waterway slips, which are centrally located, are assumed to be available and of sufficient capacity for at least some projects.

A different assumption regarding the implementation of the confined aquatic disposal option was also incorporated into the revised cost estimates. Implementation of the confined aquatic disposal option was assumed to be onsite, rather than at the offsite location described in the feasibility study. The offsite location was determined to be problematic due to technical considerations (e.g., the depth was 100-200 feet) and because transport of untreated sediments to the facility would be in conflict with the Superfund offsite policy.

11. STATUTORY DETERMINATION

Under CERCLA, EPA's primary responsibility is to undertake remedial actions that assure adequate protection of human health and the environment. In addition, Section 121 of CERCLA established several other statutory requirements and preferences for cleanup. These specify that when complete, the selected remedial action for the site must comply with applicable or relevant and appropriate environmental standards established under federal, state, or tribal environmental laws unless a statutory waiver is justified. The selected remedy must also be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element. The following sections discuss how the selected remedy meets these statutory requirements.

11.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy protects human health and the environment through source control measures that eliminate major sources of contaminants to the marine environment, especially in relation to bottom sediments in each of the eight CB/NT problem areas addressed in this Record of Decision. The remedy also provides for sediment confinement measures that isolate contaminated sediments from sensitive and edible marine resources. Sediment confinement options include *in situ* capping, confined aquatic disposal, nearshore disposal, and upland disposal.

In the CB/NT area, the current risks to public health are associated primarily with consumption of seafood organisms that have accumulated PCBs from contaminated sediments. For baseline conditions evaluated during the remedial investigation, the estimated lifetime risks associated with consumption of 1 pound/month (15 grams/day) of Commencement Bay fish were about 2×10^{-4}. Remediation of sediments containing over 150 µg/kg PCBs should result in fish tissue concentrations similar to those in fish from Carr Inlet, a relatively uncontaminated reference area in Puget Sound. Sediment remediation at this level would reduce the excess lifetime risks associated with PCBs contamination in Commencement Bay fish to about 4×10^{-5} for a seafood consumption rate of 12.3 grams/day, which has recently been identified as an average fish consumption rate for the Puget Sound area. Those individuals who are consuming seafood from the CB/NT site at a greater or lesser rate would experience, respectively, greater or lesser associated risks. This average post-remediation risk level is within the acceptable range of risks (10^{-7} to 10^{-4}) for Superfund sites.

Contamination of CB/NT sediments by a wide variety of organic and inorganic chemicals has been shown to result in substantial adverse effects to biological resources. Effects have been demonstrated using a preponderance-of-evidence approach that incorporated multiple biological indicators of sediment toxicity (sublethal and lethal) and direct effects on benthic infauna and fish communities. Because of the documented impacts to biological resources and potential impacts to human health that are evident in the CB/NT problem areas, there is a presumption of harm and/or an imminent threat posed by contaminants in these areas. In order to be protective of both the public health and the environment, a sediment quality objective has been established for these areas in which a no adverse effects level was measured by the three biological indicators and human health assessment methods described in this Record of Decision. These biological effects indicators were also used to develop empirical sediment quality values (AET) that relate measured biological effects to concentrations of chemical contaminants. Validation studies in Puget Sound have demonstrated that AET have a high reliability (86-96 percent) in predicting the presence or absence of adverse biological effects. Therefore, remediation of Commencement Bay sediments to contaminant levels based on AET should ensure that biological conditions would improve to levels characteristic of Puget Sound reference areas, the function of high quality habitat would be restored, and fisheries would be enhanced.

11.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The selected remedy of source control, natural recovery, and sediment confinement (i.e., *in situ* capping and/or onsite disposal) will comply with all action-, chemical-, and location-specific ARARs. The ARARs are presented below.

11.2.1 Action-Specific ARARs

Sediment remedial activities (i.e., capping, dredging, and/or disposal of contaminated sediments) will meet the following action-specific ARARs:

- Requirements for upland disposal of RCRA hazardous waste as established in 40 CFR 246, 264, 265, 268 Subpart D, and 52 CFR 8712
- Washington state Hazardous Waste Management Act (RCW 70.105) requirements for upland disposal of solid waste, dangerous waste, and extremely hazardous waste as codified in WAC 173-303-081 and WAC 173-303-650
- Substantive requirements and guidelines of Clean Water Act Section 404 (40 CFR 125) as implemented by the Corps and EPA (e.g., for dredging and dredged materials management, including designation of disposal sites)
- Requirements of the state water quality certification process pursuant to Clean Water Act Section 401 (40 CFR 125) (i.e., actions must not result in a violation of water quality standards or other state policies, requirements, and laws that pertain to the aquatic environment and beneficial use protection)
- Substantive requirements of the Washington Department of Fisheries and Washington Department of Wildlife hydraulics permit (e.g., design and performance constraints and timing of action)
- Requirements of Washington Model Toxics Control Act (Initiative 97) for managing hazardous waste site cleanups, Chapter 2, Laws of 1989
- Washington Shoreline Management Act requirements for activities conducted within 200 feet of shorelines of statewide significance (RCW 90.58, WAC 173-14)
- Washington state requirements for interference with the natural flow of state waters as set forth in RCW 75-20.100 and WAC 220-110
- The Puyallup Tribe of Indians Settlement Act of 1989 (public law 101-41, 21 June 1989) requiring substantial restoration and enhancement of the fisheries resource in the Commencement Bay area
- Puyallup Tribe Water Quality Program (Puyallup Tribal Council Resolution No. 71288) adopting Washington Water Quality Standards and protecting fishing rights, habitat values, surface water, and groundwater.

Source control activities will meet the following action-specific ARARs:

- Washington state Hazardous Waste Management Act (RCW 70.105) requirements for upland disposal of solid waste, dangerous waste, and extremely hazardous waste as codified in WAC 173-303-081 and WAC 173-303-650
- Requirements of Washington Model Toxics Control Act (Initiative 97) for managing hazardous waste site cleanups, Chapter 2, Laws of 1989
- Requirements for discharges to publicly owned treatment works as established in 40 CFR 403.5, 264.71, and 264.72

- Conditions stated in the pertinent NPDES permits governing direct discharges including storm drain outfall to Commencement Bay waters (40 CFR 125.122, 125.123, 125.124)
- Conditions stated in the pertinent pretreatment permits governing direct discharges to city of Tacoma sanitary sewers
- Puyallup Tribe Water Quality Program (Puyallup Tribal Council Resolution No. 71288) adopting Washington Water Quality Standards and protecting fishing rights, habitat values, surface water, and groundwater
- Washington Water Pollution Control Act (RCW 90.48) requirements governing discharges of any pollutant to waters of the state
- Washington Shoreline Management Act requirements for activities conducted within 200 feet of shorelines of statewide significance (RCW 90.58, WAC 173-14)
- The Puyallup Tribe of Indians Settlement Act of 1989 (public law 101-41, 21 June 1989) requiring substantial restoration and enhancement of the fisheries resource in the Commencement Bay area.

11.2.2 Chemical-Specific ARARs

Sediment remedial activities may be required to meet the following chemical-specific ARARs depending on the activity in question (e.g., dredging, dredged material disposal):

- Limiting permissible concentrations established by 40 CFR 125.120-125.124; 227.22, and ambient water quality criteria for protecting human health and aquatic organisms established by 40 CFR 131
- Groundwater protection requirements for RCRA facilities as established by 40 CFR 264 and 265
- Federal requirements for groundwater used as drinking water as set forth in 40 CFR 141 and 143
- Federal regulations (implemented by 40 CFR 261.24) requiring an extraction procedure toxicity test for contaminant leaching trigger handling and disposal requirements
- Washington water quality standards for surface waters (WAC 173-201)
- Water Pollution Control Act (RCW 90.48) and Water Resources Act (RCW 90.54) require the use of AKARTs for controlling discharges to surface water and groundwater.

The above standards may be exceeded on a short-term, localized basis during dredging or sediment disposal operations due to resuspension of contaminated sediment.

Source control activities will meet the following chemical-specific ARARs:

- Water Pollution Control Act (RCW 90.48) and Water Resources Act (RCW 90.54) require the use of AKARTs for controlling discharges to surface water and groundwater
- Technology-based standards established in Clean Water Act Section 301(b)
- Limiting permissible concentrations for discharges into marine waters pursuant to 40 CFR 125.120-125.124; 227.22
- Ambient water quality criteria for the protection of aquatic life and human health established by 40 CFR 131
- Washington water quality standards for surface water as established by WAC 173-201.

11.2.3 Location-Specific ARARs

Sediment remedial activities will meet the following location-specific ARARs:

- Clean Water Act Sections 404 and 401 (40 CFR 125) substantive requirements for dredged material evaluation and impacts assessment (including wetlands protection)
- Rivers and Harbors Appropriations Act Section 10 substantive requirements for protecting navigable waterways
- Puyallup Tribe Land Claim Settlement requirements for actions that impact fisheries resources in the Puyallup River delta
- Executive Orders 11990 and 11988 (40 CFR 6 Appendix A) to avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial uses of wetlands and floodplains.

Source control remedial activities will meet the following location-specific ARARs:

- Washington Shoreline Management Act requirements for activities conducted within 200 feet of shorelines of statewide significance (RCW 90.58, WAC 173-14)
- Washington state Hazardous Waste Management Act (RCW 70.105) requirements for upland disposal of solid waste, dangerous waste, and extremely hazardous waste as codified in WAC 173-303-081 and WAC 173-303-650
- Requirements of Washington Model Toxics Control Act (Initiative 97) for managing hazardous waste site cleanups, Chapter 2, Laws of 1989.

11.2.4 Other Factors To Be Considered

Sediment remedial action will consider the following:

- Requirements and guidelines for evaluating dredged material, disposal site management, disposal site monitoring, and data management established by PSDDA (1988)
- Critical toxicity values (acceptable daily intake levels, carcinogenic potency factor) and U.S. Food and Drug Administration action levels (for concentrations of mercury and PCBs in edible seafood tissue)
- Pending TPCHD regulations for sanitary landfills
- Substantive land use requirements of the Tacoma Shoreline Master Program
- *EPA Wetland Action Plan* (U.S. EPA 1989) describing National Wetland Policy and goal of no net loss
- 1989 PSWQA plan (PSWQA 1988) Elements P-2 and P-3 for sediment quality standards and sediment impact zones
- 1989 PSWQA plan (PSWQA 1988) Elements S-4, S-7, and S-8 for confined disposal, cleanup decisions, and investigations and cleanups of contaminated sediment.

Source control actions will consider the following:

- AKART guidelines and 1989 PSWQA plan (PSWQA 1988) Elements P-5 and P-7 for the development of AKART guidelines and effluent limits for toxicants and particulates
- **1989 PSWQA plan (PSWQA 1988) Element P-3 for the development of criteria for defining sediment impact zones relative to discharges.**

11.3 COST EFFECTIVENESS

The cost of the selected remedy is described in terms of sediment-related activities only, because source controls are being enforced largely according to non-CERCLA environmental authorities and programs. The net present worth value represented by *in situ* capping for St. Paul Waterway is estimated to be $1,820,000 (actual costs for capping not provided by Simpson Tacoma Kraft Company for this Record of Decision). The cost of implementing the selected remedy in the remaining seven problem areas will vary according to the types of confinement options actually utilized. Because the confined aquatic disposal option can be implemented within each problem area, site availability is less of a limiting factor. It is therefore the most likely option to be implemented on an areawide basis and is the only option for which areawide costs are presented. The net present worth value for implementing confined aquatic disposal in the remaining seven problem areas is estimated to be $30,500,000.

The total estimated cost of sediment-related activities in all eight CB/NT problem areas addressed in this Record of Decision is therefore $32,300,000. Costs associated with *in situ* capping are approximated a factor of 0.5 less, costs associated with nearshore disposal are approximately a factor of 0.8 less, and costs associated with upland disposal are approximately a factor of 2 greater than those associated with confined aquatic disposal. It is expected that the remedy implemented at these problem areas will represent a combination of these confinement options, which would be reflected in actual costs. Revisions in estimates to the cleanup volume based on the results of remedial design sampling are expected to have a major impact on these cost estimates. However, the selected remedy is cost-effective because it has been determined to provide overall effectiveness relative to costs of the other remedies evaluated for sediment remedial action.

Because natural recovery is included as a key element of the overall alternative, the estimated costs of the remedy are approximately one-half of what they would be if the remedy did not incorporate natural recovery over a 10-year time period. The estimated costs of the selected remedy are at least one-tenth of the costs associated with incineration, and at least one-quarter of the costs associated with treatment of sediments by solvent extraction, and at least one-half the costs associated with solidification. These comparisons to treatment costs are derived from feasibility study cost estimates, which are assumed to be valid for comparison purposes.

By providing for flexibility in the disposal site option, the selected remedy provides a cost-effective means of achieving the project objective: acceptable sediment quality in a reasonable timeframe. Nearshore disposal can be integrated into planned construction projects that require fill. Similarly, disposal location siting can take into consideration the unique use requirements of each of the remaining seven problem areas to minimize economic impacts associated with implementation of the selected remedy (e.g., shipping traffic disruption), or associated with projected uses of the waterways.

11.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT/ TECHNOLOGIES

EPA and the state of Washington have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner at the CB/NT site. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA and the state have determined that the selected remedy provides the best balance of tradeoffs in terms of long-term effectiveness and permanence; reduction in toxicity, mobility or volume achieved through treatment; short-term effectiveness; implementability; and cost. The selected remedy also offers the highest degree of overall acceptance by the state, tribe, and affected community.

While the selected remedy does not include treatment (i.e., solvent extraction, solidification, incineration) as a principal element in sediment remedial actions, it will significantly reduce the inherent hazards posed by the contaminated sediments through isolation and source control. The principal threat posed by contaminated sediments is through exposure of resident benthic communities living at or near the sediment-water interface, fish that feed on benthic organisms or live in close association with surface sediments, and humans who consume organisms that have been exposed to the sediments and have accumulated contaminants. Burial of the contaminated sediments, either through natural accumulation of clean sediments, or through confined aquatic disposal, eliminates the potential rates of exposure. Source control ensures that this very sensitive interface will not be recontaminated, and monitoring verifies that source controls and sediment remedial actions have been effective.

11.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

This decision to confine sediment either in-place or in onsite disposal facilities is consistent with program expectations, which focus treatment technologies on more highly toxic, concentrated wastes. In general, sediment contamination at the CB/NT site is characterized by very large volumes of low concentration material. Because contaminant releases to the marine environment have often been slightly dispersed in the water column as they settle, and are further mixed with clean, naturally occurring particles as they accumulate on the bottom, they tend to be relatively dilute as compared to more concentrated waste materials. Furthermore, contaminants that have accumulated in the sediments typically have a strong affinity for particles. Thus, once in place, most sediment contaminants are relatively stationary unless the particles with which they are associated are disturbed and remobilized. The potential for remobilization of particles within a confined disposal facility is relatively remote if the facility is properly designed and engineered.

12. DOCUMENTATION OF SIGNIFICANT CHANGES

The proposed plan for the CB/NT site was released for public comment in February 1989. The proposed plan described the preferred alternatives identified in the feasibility study for the nine problem areas then included in the investigation, and identified a more general performance-based alternative as the preferred alternative. Since that time, the following changes have been made:

1. **Project Scope:** The problem area designated Ruston-Pt. Defiance Shoreline has been established as a separate operable unit for the site: Operable Unit 06 (ASARCO Sediments) (described in greater detail in Section 5.1.6), reducing the number of problem areas addressed in this Record of Decision to eight.
2. **Source Control:** Source control has been established as an operable unit for the site which will be managed according to the objectives described in this Record of Decision.
3. **Habitat Objectives:** The importance of habitat restoration and fisheries enhancement has been clarified as a component of the CB/NT cleanup objective.
4. **Selected Remedy:** A limited range of four confinement options was selected to represent the sediment remedial action element of the selected alternative.
5. **Cost Estimates:** Adjustments to cost estimates were made.
6. **Timeframe for Implementation Schedules:** Planning schedules for overall project implementation were adjusted.

These changes are logical outgrowths of the proposed plan, and are based on new information provided during the public comment period.

12.1 PROJECT SCOPE

The Ruston-Pt. Defiance Shoreline problem area described in the feasibility study has been designated as a separate operable unit. This reduces the number of problem areas addressed in this Record of Decision to eight.

This change in project scope was made because the agencies received a remedial investigation for the ASARCO Tacoma smelter and off-shore sediments as a comment to the CB/NT feasibility study during the public comment period. This report included detailed new information about characteristics, areal extent, and volume of contaminated sediments along the Ruston-Pt. Defiance Shoreline. The agencies have reviewed this information and believe that further detailed analysis of remedial alternatives for this problem area is needed. The new information submitted during the comment period indicates that sediment toxicity problems associated with coarse-grained slag particles unique to the Ruston-Pt. Defiance Shoreline may be less severe than predicted in the CB/NT feasibility study. Therefore, significant changes regarding the estimated volume of contaminated sediments, the preferred sediment remedial alternative, and the cost of this remedy can be anticipated. The information is specific to the Ruston-Pt. Defiance Shoreline sediments, and does not alter the selection of remedy for the other eight problem areas.

Once the agencies have fully evaluated the feasible remedial alternatives for this problem area, EPA and Ecology will issue a new proposed plan for a 30-day public comment period. After consideration of public comments, the agencies will select a remedy for the operable unit and issue another Record of Decision specific to the CB/NT Ruston-Pt. Defiance Shoreline problem area.

12.2 SOURCE CONTROL

Source control has been described previously as the most challenging and critical first step in the overall response strategy for the CB/NT site (Section 5.1). Ecology's Commencement Bay UBAT was established in response to that challenge and is currently undergoing an expansion as a result of additional resources made available through a Superfund cooperative agreement. To more effectively manage that cooperative agreement and source control as a key element in the selected remedy, Operable Unit 05 (Source Control) was established in the spring of 1989. Public comment received on the CB/NT feasibility study indicated a very broad-based consensus that enhanced source control measures were important to overall project success.

12.3 HABITAT OBJECTIVES

The role of habitat function as an important component of the overall project objectives was expanded and clarified in response to three related issues presented during the public comment period. First, concerns were raised that dredging activities could compromise important habitat, particularly in intertidal environments. Second, various comments were received indicating that impacts affecting habitat function should be evaluated in relation to impacts associated with contamination problems. Third, the Puyallup Tribe of Indians Settlement Act of 1989 was promulgated, requiring substantive protection and enhancement of fisheries resources in the Commencement Bay area. The habitat restoration protocols being developed by EPA's Region 10 Wetlands Program and Puget Sound Estuary Program will be incorporated into habitat evaluation in the CB/NT problem areas before and after sediment remedial action at both dredging and disposal sites. These protocols are being designed to quantitatively assess those characteristics of an area that contribute to habitat function (i.e., feeding, refuge, and reproduction). Habitat function has been included conceptually as a remedial objective that will be addressed in sediment remedial design.

12.4 SELECTED REMEDY

In the proposed plan for the feasibility study, the agencies recommended that a performance-based remedy that could incorporate multiple sediment remedial options would be preferable to one that limited remedial action to a single specific technology. The recommendation was based on evaluations in the feasibility study indicating that all four confinement options offered similarly feasible and cost-effective means of achieving the project cleanup objectives.

However, in the CB/NT feasibility study, a preferred remedy was identified for each problem area which included a specific confinement option (e.g., nearshore disposal was preferred for the Head of Hylebos Waterway). The decision to define a generalized confinement element for sediment remediation instead of the specific confinement options identified in the feasibility study or a performance-based remedy as recommended in the feasibility study was based on comments received during the public comment period, and additional technical and administrative review conducted by EPA and Ecology. This decision affects only the sediment remedial action element of the remedy. Source control and natural recovery remain key elements of each problem area remedy.

The preferred alternative identified in the CB/NT feasibility study and the selected remedy described in Section 10 are summarized in Table 15. The remedy selected for the St. Paul Waterway problem area represents one of the four confinement options: *in situ* capping. For the Mouth of Hylebos, Head of City, and Wheeler-Osgood problem areas, open-water confined aquatic disposal was identified as the preferred alternative in the feasibility study. Nearshore disposal was identified in the feasibility study as the preferred alternative for Head of Hylebos, Sitcum and Middle problem areas. Institutional control (including natural recovery) was selected as the preferred alternative for the Mouth of City Waterway problem area.

TABLE 15. SEDIMENT REMEDIES SELECTED IN THE FEASIBILITY STUDY AND RECORD OF DECISION

Problem Area	Feasibility Study	Record of Decision
Head of Hylebos	Nearshore disposal	Confined disposal[a]
Mouth of Hylebos	Confined aquatic disposal	Confined disposal[a]
Sitcum	Nearshore disposal	Confined disposal[a]
St. Paul	*In situ* capping	*In situ* capping
Middle	Nearshore disposal	Confined disposal[a]
Head of City	Confined aquatic disposal	Confined disposal[a]
Wheeler-Osgood	Confined aquatic disposal	Confined disposal[a]
Mouth of City[b]	Institutional controls	Confined disposal[a]

[a] *In situ* capping, confined aquatic disposal, nearshore disposal, upland disposal.

[b] Predicted to recover following source controls.

After consideration of public comment, a limited range of confinement options was determined to offer the most appropriate means of achieving the project cleanup objectives in a timely manner. The four different confinement options provide comparable protection of human health and the environment, and they are similarly comparable when evaluated by the balancing criteria. Variations in long- and short-term effectiveness and permanence are relatively minor and are given less weight than if the waste were higher in contaminant concentration. This added flexibility also addresses cost concerns. For example, it is recognized that the added costs associated with upland disposal may be justified for selected areas where *in situ* capping, nearshore disposal, or confined aquatic disposal could interfere with commercial and navigational activities. In addition, new information collected during remedial design sediment sampling could greatly influence the selection of the specific confinement option. It is anticipated that the spatial extent of contamination exceeding sediment quality objectives and the areal extent of sediment predicted to recover naturally could change significantly based on more detailed information on the distribution of contamination concentrations, site-specific biological test results, refined sedimentation rates, improved information on source loading rates, and new information on chemical degradation and loss rates. Changes in waste volume will significantly impact the capacity requirements of disposal sites and consequently influence the overall disposal site design.

12.5 COST ESTIMATES

Comments received during the public comment period suggested that costs associated with candidate alternatives were underestimated. Subsequent review of the costing procedures indicated that unit dredging costs were underestimated by approximately a factor of 2, and that bulking factors due to incorporation of water during dredging were not included. The costs developed in the CB/NT feasibility study were used to analyze the costs of the treatment alternatives relative to the costs of confinement alternatives. New costs were developed for the four confinement options using more realistic estimates for unit dredging costs and bulking during dredging. Other cost refinements were also developed on the basis of revisions to the preferred alternatives and changes in assumptions regarding the factors that would influence their implementation. For example, nearshore disposal cost estimates do not include site development because it has been determined that this alternative will only be implemented when integrated into nearshore construction projects. The cost estimates developed for the Record of Decision for confined aquatic disposal assume that overdredging techniques will be used.

12.6 IMPLEMENTATION SCHEDULES

The implementation schedules for both source control and sediment remediation as described in the CB/NT integrated action plan (PTI 1988) have been revised in response to public comment. Many comments indicated that the estimated schedules appeared to be based on unrealistically short timeframes for source control. The schedules have been re-evaluated by EPA and Ecology for each of the CB/NT problem areas. In general, the schedules were revised to include 1-3 more years of source control activities. The schedule revisions have been adjusted to reflect additional time needed to investigate and address CB/NT sources, including storm drains, that were not factored into the integrated action plan schedules. The overall timeframe for the action cleanup phase of the project has therefore been adjusted from 4 years to a total of 8 years, as reflected in the planning schedules in Appendix C.

REFERENCES

Crecelius, E.A., M.H. Bother, and R. Carpenter. 1975. Geochemistry of arsenic, antimony, mercury and related elements in sediments of Puget Sound. Environ. Sci. Technol. 9:325-333.

Gahler, A.R., J.M. Cummins, J.N. Blazevich, R.H. Rieck, R.L. Arp, C.E. Gangmark, S.V.M. Pope, and S. Filip. 1982. Chemical contaminants in edible, non-salmonid fish and crabs from Commencement Bay, Washington. EPA-910/9-82-093. U.S. Environmental Protection Agency Region 10, Seattle, WA. 118 pp.

Hart Crowser. 1984. Soil and groundwater quality evaluation, SR-705 Tacoma Spur, Tacoma, Washington. Prepared for ABAM Engineers, Washington State Department of Transportation, and Washington Department of Ecology. No. J-1210-09. Hart Crowser & Associates, Seattle, WA.

Malins, D.C., B.B. McCain, D.W. Brown, A.K. Sparks, and H.O. Hodgins. 1980. Chemical contaminants and biological abnormalities in central and southern Puget Sound. NOAA Technical Memorandum OMPA-2. National Oceanic and Atmospheric Administration, Boulder, CO. 295 pp.

Malins, D.C., B.B. McCain, D.W. Brown, A.K. Sparks, and H.O. Hodgins. 1982. Chemical contaminants and abnormalities in fish and invertebrates from Puget Sound. NOAA Technical Memorandum OMPA-19. National Oceanic and Atmospheric Administration, Boulder, CO. 168 pp.

Norton, D., and A. Johnson. 1985. Assessment of log sort yards as metals sources to Commencement Bay waterways, November 1983-June 1984. Completion report for WQIS Project I for the Commencement Bay nearshore/tideflats remedial investigation. Washington Department of Ecology, Olympia, WA.

Parametrix. 1987. St. Paul Waterway remedial action and habitat restoration project: project overview, SEPA environmental checklist, technical appendices. Prepared for Simpson Tacoma Kraft Company. Parametrix, Inc., Bellevue, WA.

Phillips, K.E., J.F. Malek, and W.B. Hamner. 1985. Evaluation of alternative dredging methods and equipment, disposal methods and sites, and site control and treatment practices for contaminated sediments. U.S. Army Corps of Engineers, Seattle, WA.

Pierce, D., A. Comstock, and R. Young. 1987. Marine resource protection program seventh progress report. Prepared for the Tacoma City Council. Tacoma-Pierce County Health Department. Environmental Health Division, Waste and Water Section, Tacoma, WA.

PSDDA. 1988. Evaluation procedures technical appendix - Phase I (central Puget Sound). Public Review Draft. Prepared by the Evaluation Procedures Work Group for Puget Sound Dredged Disposal Analysis. U.S. Army Corps of Engineers, Seattle, WA.

PSWQA. 1988. 1989 Puget Sound water quality management plan. Puget Sound Water Quality Authority, Seattle, WA. 276 pp.

PTI. 1988. Commencement Bay nearshore/tideflats integrated action plan. Public Review Draft. Prepared for Tetra Tech, Inc., and the Washington Department of Ecology. PTI Environmental Services, Bellevue, WA.

PTI. 1989. Commencement Bay nearshore/tideflats feasibility study: development of sediment cleanup goals. Public Review Draft. Prepared for Tetra Tech, Inc., Washington Department of Ecology, and the U.S. Environmental Protection Agency. PTI Environmental Services, Bellevue, WA.

Riley, R.G., E.A. Crecelius, and D.C. Mann. 1980. Quantitation of pollutants in suspended matter and water from Puget Sound. NOAA Technical Memorandum ERL MESA-49. National Oceanic and Atmospheric Administration, Boulder, CO. 99 pp.

Riley, R.G., E.A. Crecelius, and M.L. O'Malley. 1981. Organic pollutants in waterways adjacent to Commencement Bay (Puget Sound). NOAA Technical Memorandum OMPA-12. National Oceanic and Atmospheric Administration, Boulder, CO. 90 pp.

Rogers, T., E. Howard, and R. Young. 1983. Commencement Bay nearshore/tideflats drainage system investigation. Washington Department of Ecology, Olympia, WA.

Stinson, M., D. Norton, and A. Johnson. 1987. An investigation into potential sources of PCB contamination in Hylebos Waterway. Washington Department of Ecology, Olympia, WA.

Tetra Tech. 1985. Commencement Bay nearshore/tideflats remedial investigation. Vols. 1 and 2. Final Report. EPA-910/9-85-134b. Prepared for Washington Department of Ecology and U.S. Environmental Protection Agency. Tetra Tech, Inc., Bellevue, WA.

Tetra Tech. 1988a. Commencement Bay nearshore/tideflats feasibility study. Public Review Draft. Prepared for the Washington Department of Ecology. Tetra Tech, Inc. Bellevue, WA.

Tetra Tech. 1988b. Health risk assessment of chemical contaminants in Puget Sound seafood. Prepared for U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Seattle, WA. Tetra Tech, Inc., Bellevue, WA. 102 pp. + appendices.

U.S. EPA. 1986. Quality criteria for water. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, DC.

U.S. EPA. 1988. Guidance for conducting remedial investigations and feasibility studies under CERCLA. Interim Final Report. OSWER Directive 9355-23.01. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response and Office of Solid Waste and Emergency Response, Washington, DC.

U.S. EPA. 1989. EPA wetland action plan (January 1989). U.S. Environmental Protection Agency, Office of Water and Wetland Protection, Washington, DC.

APPENDIX A

Letters of Concurrence

CHRISTINE O. GREGOIRE
Director

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Mail Stop PV-11 • Olympia, Washington 98504-8711 • (206) 459-6000

September 27, 1989

Mr. Robie Russell
Regional Administrator
EPA Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Dear Mr. Russell:

The Washington Department of Ecology has completed its review of the Record of Decision (ROD) for the Commencement Bay Nearshore/Tideflats project. Based on this review, the State concurs with the selected remedy.

I am glad the ROD includes a range of options for sediment disposal. EPA's willingness to work with Ecology and the Puyallup Tribe in refining a list of Applicable or Relevant and Appropriate Requirements (ARAR's) is an excellent step in ensuring that the cleanup will meet the requirements of federal, state, and tribal laws. Also, we look forward to further clarifying the process for determining when sources have been controlled sufficiently to allow sediment cleanup to proceed.

I appreciate the long hours both EPA and Ecology staff have contributed to complete the ROD on schedule. We look forward to working with EPA, the Tribe, the environmental community, and Commencement Bay responsible parties in the upcoming phases of source control and sediment remediation.

Sincerely,

Christine O. Gregoire
Director

COG:kmk

cc: Mike Gallagher
Carol Fleskes
Rich Hibbard
Terry Husseman
Bill Sullivan-Puyallup Tribe
Mike Wilson-SWRO

RECEIVED
SEP 29 1989
SUPERFUND BRANCH

THE DU BEY LAW FIRM
3110 BANK OF CALIFORNIA CENTER
900 FOURTH AVENUE
SEATTLE, WASHINGTON 98164-1002

RICHARD A. DU BEY
SCOTT M. MISSALL
GRANT D. PARKER

TELEPHONE
(206) 621-7034
FACSIMILE
(206) 621-7110

September 29, 1989

HAND-DELIVERED

Mr. Robie G. Russell
Regional Administrator
U.S. Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, Washington 98101

RE: Tribal Concurrence on Commencement Bay Final Record of Decision

Dear Mr. Russell:

This letter is written on behalf of the Puyallup Tribe of Indians with regard to the letter you received from Chairman Henry John regarding the above-referenced matter on September 26, 1989. Based upon subsequent conversations among Tribal and EPA representatives, the issue arose concerning the status of the Tribe's "conditional concurrence" as set forth in Chairman John's letter of September 26, 1989. Please be advised that the Puyallup Tribe of Indians has concurred with the selection of remedy as set forth in the final draft record of decision ("ROD") for the Commencement Bay Superfund site.

Please be further advised that the Tribe reserves the right to fully participate in selection of the alternative to be implemented by EPA on a site specific basis. The Tribe also agrees with EPA that there is indeed a need for further testing and analysis to fully determine the remedy to be implemented in a manner consistent with the Superfund law.

It is understood between the Tribe and EPA that the list of concerns and conditions set forth in Chairman John's September 26th letter continue to be concerns of the Tribe with regard to the implementation phase of the selected remedy. Accordingly, the Tribe wishes to fully participate with EPA and the State of Washington as one of the three sovereign governments implementing and enforcing the selected remedy at the Commencement Bay/Nearshore Tideflats Superfund Site. Such actions on a part of the Tribe would include participation in remedial design, source control, and those studies and activities relevant to the protection of fishery habitat and fishery resources of the Puyallup River Basin Commencement Bay area.

It has been the consistent and vigorous position of the Puyallup Tribe that the fishery resources of Commencement Bay be protected and that measures be taken to implement the ROD consistent with the need to protect such treaty protected fishery resources. The Puyallup Tribe appreciates EPA's acknowledgement of the settlement legislation, settlement agreement and technical appendices as component parts of the clean up standards or ARARs, and looks forward to working with EPA in the implementation phase of the remedial action.

As previously discussed with the Superfund Site Manager and EPA Office of Regional Counsel, it is critical that EPA make additional resources available to the Tribe so that the Tribe may meaningfully participate in the remedial design and remedy implementation stages of the clean up. Our Superfund agreement may serve as a foundation upon which to base a fuller measure of federal support for the Tribe's participation and we look forward to initiating discussions with you in this regard.

On behalf of the Tribal Council, I again want to express appreciation for the hard work of the EPA Region X staff, and we look forward to a continuing government-to-government relationship directed to protection of the fishery and treaty resources of the Puyallup Tribe and the people of the State of Washington.

Sincerely,

THE Du BEY LAW FIRM

RICHARD A. Du BEY
Special Environmental Counsel
Puyallup Tribe of Indians

RAD:rb
cc: Henry John, Chairman, Tribal Council
Roileen Hargrove, Vice-Chair, Tribal Council
Gabe Landry, Councilmember
Nancy Shippentower, Councilmember
Herman Dillon, Jr., Councilmember
Bill Sullivan, Director, Environmental Programs
John Bell, Reservation Attorney
R. Randall Harrison, Office of Reservation Attorney
Mike Stoner, EPA, Superfund Site Manager
Allan Bakalian, EPA, Assistant Regional Counsel

File No. 8834.1
corresp\russellltr.834

Puyallup Tribe of Indians

September 26, 1989

RECEIVED
SEP 28 1989
SUPERFUND BRANCH

Mr. Robie G. Russell
Regional Administrator
U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, WA 98101

Re: Commencement Bay Final Draft Record of Decision

Dear Mr. Russell:

The Puyallup Tribe of Indians has reviewed the final draft Record of Decision for the Commencement Bay Nearshore/Tideflats. This document is critically important to the health and well-being of members of the Puyallup Tribe. We appreciate very much the work that has gone into the document and as well as your recognition that the Tribe has a critical role in the process of directing the cleanup of Commencement Bay.

The Puyallup Tribal Council, governing body of the Tribe, has instructed me to communicate to you the Tribe's position on the final draft ROD. Although EPA has responded to many of the issues raised in the Tribe's earlier comments, we are still not convinced that the selected remedy will fully protect, among other things, human health and the fisheries habitat. We do agree, however, with the general purposes and goals stated in the ROD, and with many aspects of the selected remedy. The Tribe therefore gives its conditional concurrence to the selection of remedy in the ROD.

The Tribe's concurrence is conditioned on several factors which I will spell out. If any of those conditions are not met or satisfactorily accomplished within reasonable time limits in the planning or implementation of the remediation process, then the Tribe's response should be changed to reflect that the Tribe does not concur in the final draft ROD.

Another reason the Tribe makes its concurrence conditional is that many parts of the analysis and the proposed remedy are still undefined. Thus, if additional data is generated during the process, the Tribe reserves the right to add to and elaborate upon the conditions of its concurrence.

The Tribe agrees with the remedy selected in the ROD as long as certain conditions are met. Those conditions consist of the items identified in the Tribe's letter of June 24, 1989 (addressed to Mr. Michael Stoner of EPA and Mr. Richard Hibbard of the Washington Department of Ecology), commenting on the draft feasibility study that led to this ROD. (A copy of the June 24 letter is attached to this letter.) Although some of the problems identified by the Tribe's comments have been satisfactorily addressed in the ROD, others have not. Even in cases where the ROD has been modified to address the Tribe's concerns, there are some situations where we do not know whether the remedy selected will be satisfactory until more information is available or until we see the results of the remedial action. The Tribe therefore conditions its concurrence on compliance with all of the elements listed in the Tribe's prior comments.

The following list is a summary of the general concerns that remain, and the categories into which the conditions on the Tribe's concurrence fall. This is not an exhaustive list of the conditions on the Tribe's concurrence; see the Tribe's letter of June 24, 1989, for a more complete and detailed list.

1. The selected remedy must protect human health and the environment.

2. The cumulative health risks from all dangerous chemicals, including their synergistic effects, must be assessed and remedied.

3. The tribal ARARs must be met to protect human health, the environment, and tribal resources, including the Tribe's federally-guaranteed treaty rights.

4. The selected remedy must be a permanent solution to the existing problems.

5. The Tribe must continue to have a meaningful role in decision-making concerning the development of source control measures, design of remedial actions, and natural resource restoration.

6. The Agency of Toxic Substance and Disease Registry is in the process of revising its earlier study in order to determine whether there is a causal relationship between the bioaccumulation of hazardous substances and the alarming cancer rate among tribal members. EPA must reevaluate the remedy selected in the ROD in light of the results of that revised study.

7. There must be a more thorough study to test for the presence of dioxins. The Tribe must be provided with the data

generated by the study and included in the evaluation of that data. The selected remedy must be revised to deal with the presence of any dioxins demonstrated by the study.

One clarification and one correction need to be made to the list of ARARs on page 90 of the ROD. The Puyallup Tribe of Indians Settlement Act is noted as an ARAR applicable to "Puyallup Tribe lands." The clarification is as follows:

> The specific standards for protection of the environment which are adopted as an ARAR are found in the Agreement negotiated by the parties to the Settlement. The Settlement Act mentioned on page 90 incorporates and adopts that Agreement. We want to be sure that people are not confused when they read the Act and do not see the specific environmental standards. They are found in the Agreement.

The correction is as follows:

> The environmental standards in the Settlement Agreement are applicable to a much wider area than "Puyallup Tribe lands," if that phrase is interpreted to mean parcels of land owned by the Tribe. A shorthand means of referring to the location to which this ARAR is applicable would be "Commencement Bay/Puyallup River watershed."

The Tribe's conditional concurrence expressed in this letter does not in any way address or limit the Tribe's right to pursue and collect damages or other relief against potentially responsible parties under applicable law for harm caused to natural resources by those parties.

The Tribe's conditional concurrence expressed in this letter also does not in any way address or limit any action the Tribe may take in the future to protect and enforce its treaty-reserved fishing rights including protection of the fisheries habitat.

The Tribe's conditional concurrence expressed in this letter also does not in any way limit or bind the Tribe in discussions that are taking place and agreements that we anticipate with the Port of Tacoma concerning certain property that is to be transferred to the Tribe as part of the Settlement Agreement.

Please do not hesitate to contact our staff if discussion or clarification of any of these issues would be helpful.

Sincerely,

Henry John

Henry John
Chairman, Puyallup Tribal Council

CC: Tribal Council
Bill Sullivan
Law Office
Richard Hibbard, DOE
Mike Stoner, EPA
Richard DuBey

APPENDIX B

Responsiveness Summary

CONTENTS

Page

I. OVERVIEW B-1

STRUCTURE B-2

SCOPE OF RESPONSE TO COMMENTS B-2

II. COMMUNITY INVOLVEMENT B-3

THE PUBLIC COMMENT PERIOD B-4

FUTURE COMMUNITY RELATIONS PLANS B-4

CONCERNS RAISED DURING THE INVESTIGATION PHASE OF THE PROJECT B-5

III. RESPONSE TO COMMENTS RECEIVED DURING THE PUBLIC COMMENT PERIOD B-7

1. PROGRAM ISSUES B-7
    - 1.1. Comments Related to CERCLA Requirements B-7
    - 1.2. Comments Related to Coordination with Other Programs B-9
    - 1.3. Comments Related to ARARs and TBCs B-10

2. HUMAN HEALTH RISKS (SEAFOOD CONSUMPTION) B-11
    - 2.1. Comments Related to Baseline Risk Calculations for Human Health B-12
    - 2.2. Comments Related to Cleanup Level for Human Health B-15

3. ENVIRONMENTAL RISKS (SEDIMENTS) B-15
    - 3.1. Comments Related to Baseline Risk Concepts for Environmental Protection B-16
    - 3.2. Comments Related to Baseline Risk Calculations for Environmental Protection B-17
    - 3.3. Comments Related to Cleanup Goal for Environmental Protection B-19

4. THE APPARENT EFFECTS THRESHOLD APPROACH B-21
    - 4.1. Comments on Conceptual Basis of the AET Approach B-21
    - 4.2. Comments on the Application of the AET Approach for Decision-Making B-22
    - 4.3. Comments Related to Chemical-Specific AET Values B-22
    - 4.4. Comments on the Establishment of AET Values for the CB/NT Site B-23
    - 4.5. Comments on the Relationship of AET to Human Health B-24

5. SOURCE LOADING ESTIMATES B-25
    - 5.1. Comments on Identification of Present and Historical Sources B-25
    - 5.2. Comments on Adequacy of Nonpoint Sources Relative to Point Sources B-26
    - 5.3. Comments on Loading Calculations B-26

Page

6. SOURCE CONTROL B-27

- 6.1. Comments on the Appropriateness of Source Control B-28
- 6.2. Comments on Remedial Technologies for Source Control B-28
- 6.3. Comments on Relating Source Control to Sediment Quality Objectives B-28
- 6.4. Comments on Appropriateness of Feasibility Estimates for Source Control B-29
- 6.5. Comments on the Status of Source Control B-29

7. NATURAL RECOVERY AND THE SEDIMENT CONTAMINANT ASSESSMENT MODEL (SEDCAM) B-29

- 7.1. Comments on the Protectiveness of Natural Recovery B-30
- 7.2. Comments on Modeling Predictions Using SEDCAM B-30

8. SEDIMENT REMEDIAL ALTERNATIVES B-31

- 8.1. Comments on the Permanence of Confinement Options B-31
- 8.2. Comments on the Feasibility of Confinement Options B-31
- 8.3. Comments on the Impacts of Dredging and Disposal B-33
- 8.4. Comments on Cost and Volume Estimates B-34
- 8.5. Comments on the Cost-Effectiveness of Sediment Remedial Action B-35

9. IMPLEMENTATION AND MONITORING B-35

- 9.1. Comments on Timing of Source Control, Sediment Remedial Action, and Natural Recovery B-35
- 9.2. Comments on Time Schedules B-36
- 9.3. Comments on Routine Dredging Projects B-37
- 9.4. Comments on Source Monitoring B-37
- 9.5. Comments on Sediment Monitoring B-38

IV. REMAINING ISSUES B-40

V. ANNOTATED BIBLIOGRAPHY B-41

VI. REFERENCES B-64

GENERAL REFERENCES B-64

COMMENTS RECEIVED DURING PUBLIC COMMENT PERIOD B-66

RESPONSIVENESS SUMMARY

I. OVERVIEW

The purpose of this document is to summarize and respond to the public comments submitted in regard to the proposed plan and other alternatives for cleanup of the Commence Bay Nearshore/Tideflats (CB/NT) site. It addresses comments for the eight problem areas covered in this Record of Decision. This Responsiveness Summary is required in Section 117 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA).

The Washington Department of Ecology (Ecology) and U.S. Environmental Protection Agency (EPA) identified a preferred alternative for the CB/NT site in the feasibility study and proposed plan which were made available for public review and comment from 24 February 1989 to 24 June 1989. The agencies' preferred alternative addressed contaminated marine sediments in nine problem areas identified in the feasibility study. The agencies recommended selecting a combination of source control, natural recovery, and active remediation of those sediments in the problem areas that would not recover naturally to the sediment quality objective within 10 years. The agencies further recommended that the selected sediment remedial alternative (for areas requiring active remediation) be performance-based, rather than selecting a single specific remedy, as long as the technology chosen satisfied the performance criteria, as well as all CERCLA requirements.

The agencies have carefully considered all comments submitted during the public comment period. Based on comments received during the public comment period, members of the community are generally supportive of the overall approach that combines source control, sediment recovery, and sediment remediation, if necessary. Most commenters agreed that there are demonstrable adverse environmental impacts associated with the CB/NT sediments, that the area should support multiple uses (e.g., commercial, recreational), and that control of sources should be a high priority.

Commenters expressed divergent opinions on a number of key issues. These issues included the risks posed by the site, the proposed cleanup goals, the feasibility of and timeframe for source control, and the protectiveness and proposed role of natural recovery as a component of the remedy. Those who are not potentially responsible parties (PRPs) tended to be concerned that the cleanup objectives do not address all impacts and are not protective enough, and that the preferred alternative, particularly the natural recovery component, is neither protective nor permanent. PRPs commented in detail that the cleanup objective is too stringent, that significant health effects have not been demonstrated, that natural recovery should play a larger role, and that active remediation is warranted only in severely impacted areas. These divergent comments have been considered in the selection of remedy and responded to in Section III of this Responsiveness Summary.

The selected remedy, described in the CB/NT Record of Decision, has been modified from the proposed plan in response to comments. The changes, discussed in Section III of this Responsiveness Summary and in Section 12 of the Record of Decision, included:

- Postponing the selection of remedy for sediments in the Ruston-Pt. Defiance Shoreline problem area until further analysis of the detailed comments and new information about this area can be completed, and a new proposal presented to the public
- Establishing source control as an operable unit to be guided by this Record of Decision

- Enhancing and clarifying the role of habitat restoration and fisheries enhancement as a component of the CB/NT cleanup objective
- Selecting a range of containment options as the sediment remedial alternative rather than specifying a performance-based remedy or a single containment alternative
- Revising the cost estimates
- Lengthening the estimated time to achieve sufficient source control.

STRUCTURE

Section II briefly describes the history of community involvement in the CB/NT Superfund project from 1981 to the present (September 1989). It includes a very brief summary of key issues raised by members of the community during that time and a similarly brief discussion of how the agencies have responded to those concerns to date. A list of the community relations activities conducted at the site throughout the project is attached at the end of the Responsiveness Summary.

Section III is a summary of comments submitted during the public comment period which were germane to the selection of the remedy, and EPA's response to those comments. The comments and responses have been categorized by relevant topics and numbered.

Section IV is a very brief summary of remaining issues and concerns, and how they will be addressed during monitoring, remedial design, or remedial action. Comments submitted by ASARCO that are specifically concerned with the toxicity characteristics, and the area, extent, and volume of contaminated sediments off the Ruston-Pt. Defiance Shoreline have been deferred to the Operable Unit 06. A revised feasibility study for that problem area is currently being prepared and will be released for further public review and comment.

Section V is an annotated bibliography that has been developed to help EPA organize and respond to the large volume of comments submitted. It will also assist commenters in tracking between their original comment language and the responses provided in this appendix.

SCOPE OF RESPONSE TO COMMENTS

This Responsiveness Summary addresses the significant comments affecting selection of remedy (pro and con). It does not address many less significant comments that were nonetheless considered, or comments not germane to the remedy selection.

II. COMMUNITY INVOLVEMENT

Local concern about environmental issues focused on contamination of the marine environment in 1980-81. In 1980, the National Oceanic and Atmospheric Administration (NOAA) released a study that indicated elevated concentrations of organic compounds and metal contaminants in Commencement Bay sediments, fish, and shellfish. As a result, in January 1981, the Tacoma-Pierce County Health Department (TPCHD) issued a warning recommending the public not regularly consume the resident bottomfish or shellfish from the Hylebos, Blair, or Sitcum waterways.

In April 1981, approximately 120 persons attended a meeting called by federal, state, and local officials to explain what the government had done, was doing, and was about to do with environmental and public health problems in the Commencement Bay area. A cross section of interests were represented at the meeting, including the Puyallup Tribe of Indians, local business and industries, the Tahoma Audubon Society and the Washington Environmental Council, and individual citizens with no apparent affiliation. The later three groups were the most active participants, stressing their indignation that not enough was being done to correct the problems.

On 23 October 1981, EPA announced a list of 115 hazardous waste sites targeted for action under the new Superfund law. Commencement Bay was included on the list as the top priority site in the state of Washington at that time. That announcement strengthened the public perception that the site had serious hazardous waste problems and resulted in increased public pressure on the agencies to take action. Area residents continued to complain that not enough was done to correct the problems.

In 1981, the agencies committed themselves to making information about the agency activities and the hazards presented by contamination in Commencement Bay timely and accurate and available to all interested paries. The agencies interviewed a range of interested community members in 1983 to determine community concerns, and to plan community relations activities and opportunities for public involvement. The agencies interviewed about 30 more interested persons in 1987 to update their knowledge of community interest and concerns and to revise the community relations plan.

The most interested groups, on a continuing basis, have been local officials, the Puyallup Tribe of Indians, local businesses, local environmental and citizens groups, and other federal, state, and local agencies with an interest in this project. The most consistent community involvement has been in the form of a Citizens Advisory Committee and a Technical Oversight Committee.

The Citizens Advisory Committee was organized by TPCHD in September 1983. The Citizens Advisory Committee was originally established as a specific group of citizens from Tacoma, Vashon Island, and Pierce County, each of whom represented an organized citizen group or geographic constituency. Membership has been limited to 12-16 volunteers interested in following the agencies' progress and serving as a conduit for community interests in the investigation of Commencement Bay. Members of the committee have met regularly with agency representatives for 6 years to help provide a community and individual citizen's perspective of the process. Agency representatives have attended meetings at the request of the Citizens Advisory Committee, providing and receiving information and responding to questions. The Citizens Advisory Committee organized a citizens workshop in April 1989, to discuss and comment on the proposed plan.

Ecology and EPA established a Technical Oversight Committee during the remedial investigation to serve as a scientific and technical review panel for the project and to encourage the participation of interested local, state, and federal agencies. The Technical Oversight Committee was established in recognition of the existence of many other ongoing and related studies and overlapping environmental authorities. In addition to representatives from federal, state, and local agencies, representatives from the Puyallup Tribe of Indians, Port of Tacoma, city of Tacoma, and several local industries also served on the committee and regularly attended meetings. The Technical Oversight Committee met on an as-needed basis with at least one meeting every 3 months through the spring of 1988. The remedial investigation, risk assessment, and some preliminary feasibility study reports were reviewed by the Technical Oversight Committee prior to their release. The draft feasibility study was provided to all Technical Oversight Committee members at the beginning of the public comment period in February 1989.

More than 700 individuals and businesses have requested information about the site and have been included on the agencies' mailing list. The agencies have mailed periodic updates and fact sheets on Superfund projects in the Tacoma area to those on the mailing list. Site-specific fact sheets describing source control, interim remedial actions, the results of the remedial investigation, the draft feasibility study, and proposed plan have been distributed. Ecology and EPA representatives attended many meetings of interested citizens, industry, PRPs, and local government leaders to discuss significant milestones and cleanup action alternatives.

Much of the visible community involvement has centered on specific project developments within the overall scope of the CB/NT site, such as individual source control activities, and the ASARCO smelter. ASARCO-related concerns have consistently drawn considerable interest and involvement. Many members of the community have spoken out in favor of environmental protection in coexistence with a health economy. For example, in late 1987, a large number of environmental groups, community organizations, and citizens spoke out in favor of cleanup of the tideflats and restoration of the environment when the Simpson Tacoma Kraft Company took early action to remediate the tideflats area around the Simpson plant. Local residents are actively involved in ongoing discussions about the proper use and regulation of a municipal incinerator located in the tideflats.

THE PUBLIC COMMENT PERIOD

Media and community interest in the CB/NT site increased as the feasibility study neared completion, focusing on the costs, benefits, and other considerations of cleanup. At the request of several parties, the agencies provided for a 120-day public comment period. The agencies held two formal public meetings and the site managers met with over 20 interest groups. The public meeting transcripts are in the Administrative Record. The Citizens Advisory Committee attracted approximately 50 people to a citizens workshop designed to inform community members about these projects. During the public comment period, EPA and Ecology established an information booth at the Tacoma Fire Department Fireboat Station. Agency representatives were available at the booth 1 day per week to answer questions from members of the community. During this period, the print, radio, and television media all increased their coverage of the issues.

FUTURE COMMUNITY RELATIONS PLANS

In recognition of the scope and complexity of the CB/NT site, EPA is establishing a Technical Discussion Group for the remedial design and remedial action phase in recognition of the scope and complexity of the CB/NT site, and to integrate and expand the information exchange functions of the Technical Oversight Committee and Citizens Advisory Committee. Membership of the Technical Discussion Group is therefore intended to include the CB/NT site management team, representatives of regulatory agencies and programs, PRPs, local government, interested citizens, and organized citizens groups. The purpose of the Technical Discussion Group is to provide a forum for the general review of technical and planning issues during the cleanup phase of the project. Discussion topics may include a wide range of issues related to project status, planning, sediment management and habitat concerns, health issues, local development, and others. It is hoped that the Technical Discussion Group will provide EPA with valuable insight into issues of concern, and thereby contribute to project direction and findings. However, group input will not form EPA policy or determine EPA's course of action, nor will it preclude the 30-day public comment period required upon completion of negotiated agreements between EPA and PRPs for sediment cleanup in each of the problem areas. Meetings will be scientific and technical in nature; legal matters will not be discussed.

CONCERNS RAISED DURING THE INVESTIGATION PHASE OF THE PROJECT

Several major concerns were expressed by residents of the local community during the course of the project. These concerns are briefly summarized below, followed by summaries of the agency's response(s):

Residents questioned how reports of releases or ongoing discharges were addressed.

> **Response:** Ecology's Commencement Bay Urban Action Team (UBAT) and TPCDH's Marine Resource Protection program have responded to reported spills and discharges and ordered cleanup or other actions as appropriate. Some problems were addressed by other Ecology and EPA regulatory authorities. Work on controlling releases and ongoing discharges is a continuing activity because the site is complex, with numerous potential sources. Source control activities will be increased during the active cleanup phase of the project due to additional funding of the Commencement Bay UBAT through a Superfund Cooperative Agreement.
>
> Source control programs at a variety of facilities are already underway. For example, the Simpson Tacoma Kraft source control program has removed more than a million pounds of pollutants from the facility on an annual basis. Other elements of the source control program include chip containment and control of facilities and collection and secondary treatment of all stormwater before discharge through the new plant outfall. To address concerns over municipal storm drain discharges, the city of Tacoma has initiated a program to identify and remove existing sources of contamination, and is also studying the feasibility of treating storm runoff entering the head of City Waterway. Best management practices have been implemented at various facilities to control spillage of materials containing contaminants into the waterways. Other programs have, for example, concentrated on investigation, containment, removal, or treatment of historical wastes located on lands adjacent to the waterways.

Residents asked what potential health problems are caused by groundwater, soil, and sediment contamination, and what potential health problems might result from the consumption of contaminated fish and shellfish. Information was requested on the effects of Commencement Bay pollution on environmental quality and recreational values of Puget Sound, including protection and recovery of bottomfish and shellfish resources.

> **Response:** The agencies developed the Superfund studies to define the nature and extent of contamination, the risks from contamination, and possible solutions. According to the risk assessment, most of the health risks are based on long-term consumption of large quantities of seafood. To reduce those risks and reduce harm to the environment, the agencies worked to control or eliminate ongoing sources of pollution. TPCHD issued a fishing advisory and posted warning signs to discourage fishing in contaminated areas. Federal agencies studied seafood consumption in Commencement Bay and Puget Sound, helping the agencies to better understand and protect populations at risk. The Puget Sound Estuary Program has monitoring and restoration protocols that will be followed during remediation to ensure that the remedial activities result in enhancement of fishery resources.

Residents stressed the need for communication of potential seafood contamination dangers to residents with differences in language or cultural backgrounds.

> **Response:** TPCHD posted warning signs and notices in several languages along the waterways and shorelines to try to discourage fishing and heavy seafood consumption by residents with differing language or cultural backgrounds.

Residents expressed concern about possible job loss and economic effects on residents, the Port and city of Tacoma, tideflats business, and others. Concerns included potential adverse publicity about Tacoma's pollution problems which may drive potential new businesses from the area.

Response: In recognition of the potential adverse economic impacts of a rigid cleanup strategy, the agencies have recommended and now selected a remedy that provides maximum flexibility during implementation while still achieving the project cleanup objectives in a timely manner. The agencies must carry out their statutory mandates to protect public health and the environment. Economic concerns are therefore of secondary importance in the selection of remedy, although the agencies consider cost effectiveness when deciding among equally protective remedies. In the selected remedy, the agencies ensured protectiveness and then built in flexibility by allowing a choice between four different confinement options if sediment remedial action is necessary. This choice will be guided by technical and economic considerations, involving the port, the city, businesses, and the entire affected community.

Environmental protection, cleanup and restoration should yield long-term benefits for business as well as benefits to people and the environment. As the Tacoma News Tribune stated following the public comment period, cleanup should result in the enhancement of Tacoma's reputation as a progressive city, and promote economic growth.

Residents have consistently been concerned about public involvement in Superfund decisions and receiving timely and accurate information about area Superfund activities.

Response: The agencies have responded to this concern by working with interested citizens, including the Citizens Advisory Committee (composed of citizen volunteers and representative of organized citizens groups), publishing periodic and site-specific fact sheets, releasing significant information to the press, maintaining 16 information repositories, and holding a 120-day comment period on the proposed plan. The agencies also plan a continuing effort to facilitate information exchange between the agencies, PRPs, organized citizens groups, and citizens at large in the general review of technical and planning issues during the cleanup phase of the project (see Future Community Relations in this section).

Some residents have questioned the effectiveness of the agencies involved with the investigation and site cleanup actions, as well as the degree and effectiveness of cooperation and consistency among agencies.

Response: The agencies recognize this concern and agree that this has been a problem at times. However, the agencies believe that the proposed plan and selected remedy reflect an awareness and consideration of the opinions and concerns of the affected community, and local, state, and federal agencies. The complex, unique, and precedent-setting nature of the site has required extensive involvement, cooperation, and commitment on the part of the agencies. The Commencement Bay UBAT, Marine Resource Protection, and storm drain programs developed in response to the site are three examples of these efforts. Interagency cooperation through the Technical Oversight Committee has enabled scientific and technical review of work products. Project management support has been facilitated through the Superfund Cooperative Agreements with Ecology and the Puyallup Tribe of Indians.

Some citizens raised questions about ash and potential air emission from a proposed incinerator in the tideflats.

Response: TPCHD has monitored existing incinerator emissions and determined that they are not harmful. Future emissions have been modeled, and so long as proper procedures are followed, it is believed the emissions will continue to be safe. The health department is the appropriate agency to address these concerns.

III. RESPONSE TO COMMENTS RECEIVED DURING THE PUBLIC COMMENT PERIOD

Section III is a summary of the agencies response to comments submitted during the public comment period which were germane to the selection of the remedy. The comment period was held from 24 February to 24 June 1989. The comments and responses have been categorized by relevant topics and numbered. Section IV is a summary of comments that have not yet been fully responded to and a discussion of how they will be addressed during monitoring, remedial design, or remedial action.

Since such a large volume of comments was submitted, Section V has been included as an annotated bibliography. This section was prepared to assist commenters in tracking between their original comment language and the responses in this section.

1. PROGRAM ISSUES

Program-related comments questioned the suitability of the cleanup goal and the 10-year recovery timeframe, and the role of evolving state policy concerning sediment contamination. Comments were received from the Puget Sound Water Quality Authority (PSWQA), U.S. Army Corps of Engineers, Washington Department of Natural Resources, the Puyallup Tribe of Indians, and several private citizens. Comments generally addressed adherence to existing policies (e.g., no net loss of wetlands), programs [e.g., Puget Sound Dredged Disposal Analysis (PSDDA)], laws (e.g., CERCLA), and treaties.

1.1. Comments Related to CERCLA Requirements

1.1.1. The failure to consider alternatives for permanent treatment of wastes is contrary to Superfund regulations (CERCLA). The preferred alternatives in the feasibility study do not represent permanent solutions.

Response: CERCLA specifies a preference for permanent treatment as a principal component of the selected remedy. However, EPA guidance indicates that this preference is appropriate for wastes that are highly concentrated, toxic, and involve relatively mobile contaminants. In contrast, contaminated sediments at the CB/NT site, while toxic, involve very large volumes of relatively low concentration wastes with relatively high particle affinity (i.e., low mobility). Confinement alternatives thus offer the most cost-effective means of achieving a permanent solution at the CB/NT site.

1.1.2. The goal of "no acute or chronic adverse effects" on marine organisms is not required by any applicable law and should not be adopted as the goal for cleanup.

Response: Under CERCLA, the degree of cleanup is often set by applicable laws. However, when no applicable promulgated standards or requirements exist, cleanup levels must be developed utilizing other appropriate guidance and risk assessment methods. Since no promulgated criteria exist for sediment quality, the goals of the PSWQA plan provide important guidance on establishing CB/NT cleanup goals. Element P-2 of the plan requires Ecology to develop and adopt standards for long-term sediment quality in Puget Sound that will help prevent acute and chronic adverse effects on biological resources and significant health risks to humans.

1.1.3. The feasibility study has failed to comply with the National Contingency Plan. For example, the study is too broad (comprising the entire bay) and is based upon inadequate data for any given segment of the bay.

Response: Throughout the CB/NT Superfund project, EPA has followed the regulatory provisions contained in the National Contingency Plan (NCP). The NCP requires a remedial investigation/feasibility study prior to making cleanup decisions to gather enough data to characterize the nature and extent of contamination, and to evaluate alternative remedies for problem areas. The remedial investigation/feasibility study for the CB/NT site, therefore, began by examining the entire bay. In later phases of the study, nine specific problem areas were defined, and remedial alternatives were examined for each problem area. The remedial investigation/feasibility study database was adequate for these decisions. This Record of Decision recognizes that additional monitoring data must be gathered as part of the next phases of the project to more accurately assess source control, natural recovery rates, and the volume of contaminated sediments.

1.1.4. The Puyallup Tribe of Indians has not been provided a meaningful opportunity to participate in the development of the feasibility study. The Puyallup Tribe of Indians also maintains the feasibility study should take into consideration EPA's proposed NCP which implements SARA.

Response: The involvement of the Puyallup Tribe at the CB/NT site has been important in the remedial investigation/feasibility study as a member on the Technical Oversight Committee from 1983 to 1988. For example, the Puyallup Tribe was instrumental in identifying habitat and marine resource issues that were included in the feasibility study. The Superfund Cooperative Agreement between the Puyallup Tribe and EPA (April 1989) was the first in Region 10, and establishes the Puyallup Tribe as a supporting management agency for the project. The role of the Puyallup Tribe as a supporting agency in the selection of remedy has been important to the project and significant to the Puyallup Tribe as evidenced by their concurrence on the selected remedy. The combination of the Puyallup Tribe's historical involvement at the CB/NT site and their current status as a supporting project management agency suggests a meaningful opportunity to participate.

1.1.5. The feasibility study has failed to take into consideration the fact that much of the contamination targeted for remedial action (in some areas) is a result of a "federally permitted release" and therefore not actionable under CERCLA.

Response: Section 107(j) of CERCLA provides that response costs or damages incurred by the United States resulting from a "federally permitted release" are not recoverable under CERCLA, but only pursuant to existing law, such as other applicable federal statutes or common law. Section 101(10) of CERCLA defines a federally permitted defense by specifically enumerating certain releases in compliance with permits or authorized under federal or state environmental laws. EPA proposed regulations to define the scope of this exemption on 19 July 1988 (53 Federal Register 27268), with subsequent notices appearing in the Federal Register on 11 July 1989 (54 Federal Register 29306) and 9 August 1989 (54 Federal Register 32671). At this time, the regulations are not final.

The feasibility study is not required to evaluate or enumerate federally-permitted releases. Although there may have been federally permitted releases at the Commencement Bay site, it is not necessary to examine whether a release was federally permitted at this time. The burden of proving a federally permitted release rests with the party claiming this defense to liability. Its application is likely to be limited at the Commencement Bay site and may be more appropriately evaluated on a case-by-case basis by EPA during the cost-recovery enforcement and negotiation process.

1.1.6. Considering urban runoff, historical sources, and NPDES-permitted discharges exempt from CERCLA coverage, the Superfund should be tapped to pay at least a portion of the remediation costs at Commencement Bay.

Response: Liability under CERCLA is strict, joint, and several, meaning any party liable under Section 107(a) of CERCLA may be held responsible for reimbursement of all of EPA's costs. With the exception of federally permitted releases, there is no defense for historical contamination sources or urban runoff. Superfund monies have been used to date to pay for the entire remedial investigation/feasibility study and related enforcement costs. EPA will aggressively pursue recovery of these costs from the over 100 named PRPs at the site, and will attempt to reach settlement agreements with the PRPs for future remedial action described in the Record of Decision. To the extent that no viable PRPs are available, or if they are able to successfully prove a defense to liability, EPA may use Superfund monies for such cleanup (consistent with EPA guidance, e.g., for mixed funding) or seek to recover such costs from the other PRPs.

1.1.7. The proposed plan would not satisfy the CERCLA preference for onsite remediation where feasible.

Response: The selected remedy satisfies the preference for onsite remediation since the selected suite of sediment confinement options includes feasible onsite options including *in situ* capping, confined aquatic disposal, nearshore confinement, and upland disposal, all of which are to be implemented onsite.

1.2. Comments Related to Coordination with Other Programs

1.2.1. While apparent effects thresholds (AETs) satisfy cleanup goal requirements, these may or may not be in agreement with final state sediment quality standards. The use of alternative criteria would have major impacts on remediation plans and costs. This issue and any potential conflicts should be resolved before selection of a final remedial alternative.

Response: As noted by the commenter, the AET approach is one of the alternatives for developing state sediment quality standards and satisfies the criteria for identifying sediments having adverse effects on biological resources. Interim standards to address Element P-2 of the 1989 Puget Sound Water Quality Management Plan (PSWQA 1988) are in the process of being released by Ecology. These standards will be used to identify an inventory of contaminated sediments to be managed through various programs but not as enforcement standards for sediment cleanup. The target cleanup levels at the CB/NT site are generally higher concentrations than the interim standards as currently proposed. The PSWQA (PSWQA 1989) has supported the use of the amphipod and oyster embryo bioassays and benthic infauna analysis and the lowest AET associated with these three tests to measure compliance with the long-term cleanup goal in Commencement Bay. However, as with any Superfund project, as applicable standards and requirements are promulgated at either the federal, state, or tribal level, they will be evaluated by EPA in relationship to this Record of Decision to determine whether the selected remedy can still be considered adequately protective of human health and the environment.

1.2.2. The relationship between routine dredging projects under PSDDA and sediment remediation under CERCLA is not clear because the CB/NT sediment quality objectives are slightly more stringent than the PSDDA guidelines for open-water, unconfined disposal of sediments. Will sediments within a CB/NT problem area that pass PSDDA guidelines be accepted for disposal at a PSDDA disposal site?

Response: As a general policy, the EPA Superfund program does not intend to require PRPs to remediate sediments that could be taken to a PSDDA site. Such sediments would likely be in marginally contaminated portions of problem areas that are predicted to recover naturally and will therefore not require active remediation under Superfund. Sediments passing PSDDA guidelines may, therefore, be considered for disposal as non-Superfund wastes under Clean Water Act Section 404 regulation at a PSDDA disposal site. However, there may be situations where PRPs will be required to undertake sediment cleanup actions for sediments that pass the PSDDA guidelines. Examples of such situations include the following: elevated concentrations of PCBs or other contaminants that have a high potential for bioaccumulation in a nearshore area, but demonstrate relatively low toxicity in laboratory tests; elevated concentrations of contaminants that are highly toxic to benthic communities but exhibit relatively low toxicity in laboratory tests; highly contaminated surface sediments with relatively clean underlying sediments; and elevated contaminant concentrations at sites with low sedimentation rates.

Based on available sediment data, it does not appear that problem sediments requiring active remediation will pass the PSDDA guidelines. If they do pass, but are removed as part of the Superfund enforcement action, it is unlikely that they would be accepted at a PSDDA disposal site.

1.2.3. Ecology and EPA should continue to monitor activities in areas other than the CB/NT problem areas and require site characterization and remediation when warranted.

Response: Although agency oversight of Superfund response actions for CB/NT source control and sediment remediation will be limited to the problem areas described in this Record of Decision, EPA and Ecology will continue to investigate and regulate activities in other portions of the site. However, in areas that were not identified as high priority, the agencies will administer and enforce environmental laws and regulations including CERCLA authorities, but not as response actions related to the CB/NT site. Ecology's Commencement Bay UBAT, for example, will continue to coordinate its efforts with several other Ecology programs to address contaminated properties, wastewater discharges, air emissions and storm drains that are within the CB/NT site but not related to Superfund response actions at the site. Similarly, various other federal, state, tribal, and local programs will continue to be implemented throughout the site in circumstances that may not be related to the CB/NT selected remedy.

1.2.4. What is the regulatory status of the integrated action plan and what is its relationship to the Record of Decision? What is the process for public comment on the integrated action plan?

Response: The integrated action plan was part of the overall feasibility study for the CB/NT site and is used for resource planning and scheduling, rather than for scheduling of compliance actions. The timetables outlined in the integrated action plan are intended to be updated on an annual basis to reflect changes as overall project implementation proceeds. The integrated action plan was therefore part of the material which the public was invited to comment on during the public comment period. Because this planning document will be updated periodically, new comments and concerns should be raised to the agencies as they arise, and where possible and consistent with the law and the selected remedy, changes may be made. Information exchange between the agencies and the affected community should also be enhanced through Technical Discussion Group meetings as described in Section II of the Responsiveness Summary.

1.3. Comments Related to ARARs and TBCs

1.3.1. The 1989 PSWQA plan goals should be adopted as applicable or relevant and appropriate requirements (ARARs).

Response: The 1989 PSWQA plan does not provide promulgated criteria, standards, or requirements; rather it requires their development. Because the plan does not provide applicable or relevant and appropriate standards, criteria, or requirements, it is not listed as an ARAR. However, several plan elements (e.g., Elements P-6, P-7, P-2, and S-4) call for the development of ARARs at some point in the future. These elements are listed as major requirements, guidelines, and policies to be considered (TBCs) in the Record of Decision, in accordance with EPA guidance on compliance with other laws.

1.3.2. Maximum Contaminant Level Goals, the Indian Religious Freedom Act, and the National Historic Preservation Act must be adopted as ARARs.

Response: In a clarification letter from the Puyallup Tribe of Indians to EPA (22 August 1989), these laws were not cited as applicable or relevant and appropriate requirements and have not been included for this reason.

1.3.3. Promulgated allowable concentrations in fish of PCBs and mercury should be considered as ARARs.

Response: There are no promulgated criteria or standards for PCBs and mercury concentrations in fish tissue. The cleanup goal selected for PCBs in sediment is based on conservative risk assessment modeling. A sediment PCB concentration of 150 μg/kg (the cleanup goal) would be expected to result in a mean fish concentration of 37 μg/kg (wet weight) or less than 0.02 of the FDA action level for PCBs (2,000 μg/kg). FDA action levels are included in the list of major chemical-specific TBCs; however, they incorporate economic considerations as well as risk assessment calculations. Site-specific risk information, as developed for this Record of Decision is generally considered to be more appropriate for setting cleanup objectives. There are currently no tools available for estimating sediment mercury concentrations relative to fish tissue concentrations except risk assessment methods similar to those described in this Record of Decision.

1.3.4. Protection of human health and the environment must be the most important evaluation criteria. Federal and tribal standards must not be violated.

Response: EPA recognizes the importance of these factors in the decision-making process. CERCLA guidance requires that each remedial alternative be evaluated according to specific criteria. Both factors mentioned in this comment are reflected in what are considered the "threshold criteria" for evaluating cleanup alternatives. The threshold criteria must be met by the candidate alternatives for further consideration as possible remedies. The threshold criteria are 1) overall protection of human health and the environment, and 2) compliance with ARARs (where appropriate or relevant and appropriate federal, state, and tribal regulations are applied).

1.3.5. Interim tribal water quality standards must be considered as ARARs.

Response: The Record of Decision lists Puyallup Tribal Council Resolution No. 151288C (resolution adopting the Puyallup Tribal Water Quality Program) as a chemical-specific ARAR because this resolution adopts Washington Water Quality Standards and requires nondegradation and enhancement of water quality (this resolution also applies to sediments).

1.3.6. The Puyallup Tribe of Indians' cultural and spiritual ties to the contaminated site must be considered in the selection of remedy.

Response: Tribal Council Resolution No. 71288 is listed in the Record of Decision as a TBC. This resolution requests EPA to include tribal environmental standards within the feasibility study, and includes by reference the Tribe's fishing rights and cultural and spiritual ties to the CB/NT site.

1.3.7. The Puyallup Land Claims Settlement should be included as an ARAR.

Response: The land claims settlement is included as an ARAR for the site because it was recently promulgated as federal law and because it specifies enhancement of fish resources in the Puyallup Delta.

2. HUMAN HEALTH RISKS (SEAFOOD CONSUMPTION)

Two main categories of comments on the Commencement Bay health risk assessment and feasibility study were received. In the first series of comments, the reviewers maintained that the human health risk assessment (Versar 1985) for the CB/NT remedial investigation overestimates risks to consumers of fish and shellfish in the study area. The major comments in support of this position were submitted by the Commencement Bay Group, as prepared by ENSR (1989), and Pennwalt (1989). Other comments supporting this position included Manke Lumber (1989), Pickering (1989), Port of Tacoma (1989), public and environmental group (1989), and City of Tacoma (1989). In the second category of comments, the Puyallup Tribe of Indians (1989) maintained that the remedial investigation/feasibility study risk assessment underestimates health risks to humans consuming fish and shellfish in Commencement Bay. They suggest that the remedial investigation/feasibility study risk assessment should address cumulative health impacts to tribal families that rely on fish for large portions of their diets.

The risk estimates based on contaminant concentrations in English sole muscle tissue as part of the CB/NT remedial investigation are approximately 5 times higher than those calculated as part of the ENSR (1989) comments. The average risk estimates calculated as part of the CB/NT remedial investigation would be lower than estimates taking into account factors such as high seafood consumption rates by tribal Indians. The risk estimates for PCBs in English sole calculated during the CB/NT remedial investigation are therefore intermediate in magnitude between those estimates suggested by various commenters on the feasibility study.

2.1 Comments Related to Baseline Risk Calculations for Human Health

2.1.1 The feasibility study overestimated the human health risks in Commencement Bay by nearly an order of magnitude. This lower risk is within the generally acceptable range and is comparable to the risk reported in the feasibility study for the reference area, Carr Inlet. This indicates that sediment clean-up based on human health risk is not warranted in Commencement Bay.

Response: The baseline risk assessment for the CB/NT remedial investigation indicates an unacceptable excess risk compared with other Puget Sound reference areas. The assessment concentrated on PCBs and arsenic in muscle tissue of English sole and crab. Only PCB contamination was predicted to produce more than one cancer case over a 70-year exposure period in the exposed population. Risks from arsenic consumption in Commencement Bay seafood were less than corresponding risks in the Carr Inlet reference area. Based one these data, only data for PCBs were used in the feasibility study to establish a target cleanup level for sediments.

Only two sets of data are available to evaluate the relative excess risk of cancer associated with PCBs in English sole muscle tissue in the CB/NT waterways compared with reference areas of Puget Sound: a study by Gahler et al. (1982) and the remedial investigation (Tetra Tech 1985). Assuming equivalent fish consumption rates in the CB/NT waterways and reference area, the estimated risk of cancer associated with contamination of English sole muscle tissue would be directly related to the concentration of PCBs in the fish. Based on the data of Gahler et al. (1982) and the remedial investigation (Tetra Tech 1985), cancer risk associated with PCBs in muscle tissue of English sole from the CB/NT waterways is an order of magnitude or more greater than that associated with PCB contamination in reference areas. Therefore, an excess risk of cancer exists in the waterways relative to remote and relatively uncontaminated areas of Puget Sound. The CB/NT remedial investigation also demonstrated that PCB concentrations in English sole muscle tissue from the CB/NT waterways are elevated relative to those along the southwest shoreline of the bay.

The CB/NT remedial investigation estimated individual cancer risks for consumption of PCB-contaminated fish to be somewhere in the range from 6×10^{-3} to 2×10^{-5} (depending on the assumed consumption rate). Risk levels of 10^{-4} to 10^{-5} are higher than EPA's point of departure (i.e., 10^{-6}) for determining remediation goals. An additional lifetime cancer risk greater than 1×10^{-3} is definitely considered unacceptable. Thus, the predicted lifetime risks associated with PCB contamination of English sole muscle tissue in the CB/NT waterways may present an unacceptable excess risk compared with reference areas of Puget Sound.

Further discussions related to this comment are provided in the following portions of this section.

2.1.2. The estimate of carcinogenic potency for PCBs may be incorrect.

Response: A carcinogenic potency factor of 4.34 $(\text{mg kg}^{-1}\text{ day}^{-1})^{-1}$ was used in the CB/NT remedial investigation to calculate PCB risk from fish consumption. ENSR (1989) used a value of 7.7 $(\text{mg kg}^{-1}\text{ day}^{-1})^{-1}$ for the carcinogenic potency of PCBs to estimate risks from fish consumption in Commencement Bay. A value of 7.7 is the current carcinogenic potency factor estimated for PCB 1260 by EPA, and was used in the feasibility study to establish recommended cleanup goals for PCBs at the site. Use of the higher carcinogenic potency estimate in a revised baseline risk assessment for Commencement Bay would result in higher risk estimates by a factor of approximately 1.8 from those reported in the remedial investigation.

2.1.3. The selection of English sole as an indicator species was inappropriate for the risk assessment. The feasibility study should have used data for species that are more commonly harvested by local fishermen such as market squid, salmon, Pacific hake, and Pacific cod. This would have resulted in lower risk estimates because commenters further claimed that concentrations of PCBs in the commonly harvested species would be lower than those in English sole.

Response: The selection of English sole for the remedial investigation risk assessment was appropriate because the species could be used as an indicator for both human health and ecological risk assessment. English sole were selected because they occur in relatively large numbers in Commencement Bay. English sole also live in closer association with the sediments and would be expected to accumulate bioavailable contaminants in sediments. They were cited in the remedial investigation report (Tetra Tech 1985) as a conservative indicator of the maximum contaminant levels that would be expected to occur in edible tissue of harvested fish species. The remedial investigation acknowledges that English sole are not commonly caught by local fisherman. English sole does not necessarily represent the most contaminated species among those harvested by recreational anglers. Available data from the CB/NT waterways and Puget Sound as a whole suggest that PCB concentrations in muscle tissues of other fish species may be higher than those in English sole (Gahler et al. 1982, Tetra Tech 1985). Based on a limited number of samples, Landolt et al. (1985) found the opposite pattern (i.e., concentrations of PCBs in muscle tissue of English sole were lower than those in some commonly harvested species). Tetra Tech (1988, Figure 6) showed that mean concentrations of PCBs in muscle tissue of Pacific cod was higher than that for English sole based on data collected throughout Puget Sound. The mean concentration of PCBs in English sole (approximately 180 µg/kg wet weight) throughout Puget Sound was within a factor of approximately two times the concentration in commonly harvested species (i.e., starry flounder, Pacific hake, Chinook salmon, and rockfish) (Tetra Tech 1988).

The data cited by commenters (ENSR 1989) to support selection of commonly harvested species applied to all urban bays sampled by NOAA in 1985, not just in Commencement Bay. Moreover, corrections of consumption rate data to account for seasonal availability of species [which were not performed by ENSR (1989)] would affect the choice of dominant species in the diet of recreational anglers. PCB concentration data selected by ENSR (1989) in their alternative baseline risk assessment are biased toward low values when all data for commonly harvested species and English sole are considered. Concentration data in ENSR (1989) may have been biased toward low values because sampling locations where fish were collected were not considered (see response to Comment 2.1.5).

2.1.4. Fish consumption rates may be overestimated or underestimated.

Response: Estimates of seafood consumption rate to be used in a risk assessment depend on human subpopulations surveyed, seasonal availability of fish species, and assumptions used to calculate consumption rates from survey data. Many limitations are inherit in surveys for fish consumption rate data (Landolt et al. 1985; Pastorok 1988). Because of the uncertainties in estimating fish consumption rate, it is appropriate to use a conservatively high estimate in risk assessment. As noted earlier, risk estimates in the remedial investigation were presented for a range of consumption rates. The estimate of approximately 12 grams/day used in the feasibility study to generate a PCB cleanup objective represents the average consumption rate for Puget Sound anglers, but only about 10 percent of the anglers surveyed in Commencement Bay (Pierce et al. 1981) apparently consume seafood at a higher rate than that. The value of 12 grams/day also corresponds to the approximate average fish consumption estimated for Puget Sound anglers (Tetra Tech 1988). Adjustment of consumption rates for seasonal availability of fisheries may result in a lower estimate, but uncertainties regarding actual changes in harvest and consumption over an annual period make such corrections tenuous. Moreover, anglers may shift species preference as the availability of species changes over the year, while maintaining an approximately constant consumption rate. Therefore, the estimate of 12 grams/day represents an appropriate moderate consumption rate for recreational anglers for use in a risk assessment. However, this rate is less than the consumption rate for special subpopulations that may rely on local seafood for a large portion of their diet (e.g., consumption rates in excess of 1 pound/day were also identified in the Commencement Bay survey.

2.1.5. The effects of fishing location preference and a mixed seafood diet should be considered in developing risk estimates.

Response: Gahler et al. (1982) and the CB/NT remedial investigation (Tetra Tech 1985) provide the only data sets available for PCB concentration in muscle tissue of fish from the CB/NT waterway system. Data cited by some reviewers in support of an alternative risk assessment were taken from Tetra Tech (1988) and Landolt et al. (1985). Station locations for these studies were primarily away from the waterway system either in Commencement Bay proper (e.g., salmon data) or along the southwest shoreline of the bay. Because PCB concentrations in fish collected from the waterway system are substantially higher than those collected from other locations in Commencement Bay, data for open waters of the bay and the southwest shoreline are inappropriate for use in estimating risks associated with consumption of fish from the waterways.

2.1.6. Cumulative health risks from all dangerous chemicals such as 2,3,7,8-tetrachlorodibenzodioxin must be addressed in the establishment of a protective cleanup objective.

Response: As explained in the Record of Decision (Section 7), PCB mixtures were the only CB/NT chemicals of concern posing a human health risk above reference conditions and therefore warranting remedial action under Superfund. However, recent information developed during EPA's National Bioaccumulation Study indicates that contamination by chlorinated dioxin and furan isomers in CB/NT fish and shellfish may be comparable in terms of human health risk to those associated with PCB contamination. Thus, baseline health risks identified in the remedial investigation may be low by a factor of two. The study did not present sufficient data to compare chlorinated dioxin and furan contamination in sediments and biota with reference areas in Puget Sound, nor is it sufficient to determine the spatial distribution of contamination in Commencement Bay. Additional data will be collected as a result of planned EPA studies and as part of sampling of selected CB/NT sources and problem areas during the remedial design phase. These additional data will be used to evaluate the protectiveness of the selected remedy relative to chlorinated dioxins and furans prior to implementation of sediment remedial action.

2.1.7. The method of fish preparation for consumption may reduce contaminant concentrations. Cooking in particular may result in up to an 80 percent reduction in the PCB concentration in ingested fish.

> **Response:** It is recognized that the various methods of preparing fish for consumption may affect concentrations of PCBs in tissue consumed. Although some studies report that cooking can substantially reduce PCB concentrations in fish tissue, other studies have shown that PCB loss during cooking may be as little as 2 percent. Some cooking methods also activate or create carcinogenic chemicals. Because of the uncertainties about the net effects of cooking on PCB concentrations, corrections for the effects of cooking in the risk assessment are not possible at this time. Although the lack of correction for PCB loss in cooking may result in a slight overestimate of risk, the use of data for skinned fillets during the CB/NT remedial investigation would tend to underestimate risk. Studies have shown that PCB concentrations in unskinned fillets are higher than those in skinned fillets. Landolt et al. (1985) estimated that 19 percent of the meals consumed by Commencement Bay anglers consisted of unskinned fillets. Therefore, the actual method of fish preparation may result in either higher or lower estimated risk when compared to direct assessment of raw, skinned fillets. Because of this uncertainty, PCB concentrations were not adjusted for the preparation technique prior to consumption.

2.2. Comments Related to Cleanup Level for Human Health

2.2.1. The sediment quality objective for PCB mixtures represent a level of excess risk that is not protective to the 10^{-6} level.

> **Response:** The sediment quality objective for total PCBs at the CB/NT site represent an excess risk level of 10^{-5} for a consumption rate of 12 grams/day of English sole. The objective was established relative to both risk assessment calculations and ambient levels of PCBs in English sole caught in reference areas (which also correspond to 10^{-5} risk levels). Management of site risks was based on an assumption that it would be infeasible to establish sediment quality levels at the CB/NT site that were cleaner than reference areas. Thus, high consumers of seafood at the CB/NT site may experience risks in excess of the 10^{-6} level, even after site remediation is complete, but it will be similar to reference area risks.

3. ENVIRONMENTAL RISKS (SEDIMENTS)

Potential environmental risks of sediment contamination were evaluated in the CB/NT feasibility study using a suite of biological indicators, including sediment bioassays and *in situ* evaluations of the benthic macroinvertebrate assemblages indigenous to the bay. The primary objective of these evaluations was to provide a direct measure of the effects of sediment contamination to determine baseline risks to Commencement Bay biota. These measures were made by making statistical comparisons to conditions at relatively uncontaminated reference areas. The cleanup goals derived from the biological assessments were focused on minimizing the risk of future adverse biological effects as a result of sediment contamination in the bay.

Three major kinds of comments were received with respect to the biological indicators used in the CB/NT feasibility study. They include 1) those related to the appropriate use of biological indicators and reference areas in general, 2) those related specifically to sediment bioassays and benthic macroinvertebrate analyses, and 3) those related to the appropriateness of the cleanup goal based on environmental health. In this section, the major issues related to each of the three kinds of comments are discussed. The use of various biological indicators as assessment tools, their calculation, and application in developing the cleanup goal were questioned by several PRPs; their comments were generally summarized by ENSR (1989). The lack of chronic tests (or the exclusion of the Microtox test) for use as an assessment tool was questioned by NOAA Ocean Assessments Division, the Puyallup Tribe of Indians, and the Sierra Club.

The rationale for the selection of the biological indicators used in the CB/NT remedial investigation and the AET database is an important consideration for these issues. Biological testing was used to determine impacts of sediment chemical contamination for several major reasons. First, it allows evaluation of the potential effects of chemicals for which standards are not available and chemicals that may not be measured during typical assessments. Second, it allows assessment of the effects of complex mixtures and thereby accounts for interactions among chemicals (e.g., additive, synergistic, antagonistic). Finally, biological testing provides an empirical assessment based on the actual bioavailability of chemicals in sedimentary environments.

3.1. Comments Related to Baseline Risk Concepts for Environmental Protection

3.1.1. Appropriateness of baseline risk assessment targets some sediments for active remediation where there may be thriving ecological communities.

Response: The environmental risk assessment focused first on toxic chemicals in the marine environment with respect to reference areas, and second on the relationship to ecological function. It was recognized that all biological measurements (as well as chemical measurements) have a certain amount of uncertainty associated with their measurement and interpretation. This uncertainty arises largely from the complexity of biological systems. Because of this uncertainty, multiple biological indicators were used in the remedial investigation and AET database. The use of multiple indicators allowed impacts to be determined using a preponderance-of-evidence approach. That is, as more indicators identified a station as impacted, confidence increased that the station was truly impacted. (See the responses to Comments 3.2.3 and 3.2.4 for additional discussion on the appropriateness of designating adverse impacts based on laboratory bioassays compared with *in situ* benthic analyses.)

3.1.2. The reference areas selected for evaluation of benthic macroinvertebrates may be inappropriate.

Response: The appropriateness of the reference areas used to evaluate potentially impacted sites was questioned. Several commenters suggested that the reference areas did not match the potentially impacted areas with respect to all important characteristics, and that effects determined at the latter sites may have been due to characteristics other than chemical toxicity.

It is recognized that the characteristics of benthic macroinvertebrate assemblages are influenced by a wide variety of physical, chemical, and biological variables. Because there are so many potentially important variables, it is unlikely that a perfect reference area can be found for any potentially impacted site. Instead, it is more practical to select a reference area that is as similar as possible to the potentially impacted sites with respect to the most important variables. For the remedial investigation and AET database, the variables used to select reference sites were season, depth and sediment character (represented by sediment grain size). These variables are three of the most important ones known to influence the characteristics of benthic macroinvertebrate assemblages (Gray 1981). In addition to these three major variables, the artificial environment created by the manmade waterways of Commencement Bay was addressed by selecting a manmade waterway (i.e., Blair Waterway) as the reference area for those environments.

3.2. Comments Related to Baseline Risk Calculations for Environmental Protection

3.2.1. There is a lack of ecological relevance for bioassay test species used in the remedial investigation and the AET database. Because these indicators do not measure in situ *biological effects, they have little ability to predict impacts on the CB/NT ecosystem. The use of major taxa (i.e., Polychaeta, Mollusca, Crustacea) is too crude of a response variable to determine impacts accurately; much valuable information is lost by not considering species abundances.*

Response for use of bioassay test species: As mentioned in the introduction to this Response Section 3, the bioassay test species were selected because they are residents of Puget Sound and are relatively sensitive to chemical contamination. Their use in assessing sediment contaminant impacts has been established in many studies in Puget Sound and elsewhere (PTI and Tetra Tech 1988; Chapman et al. 1985, 1987). Because they represent one of the most sensitive ecosystem components, their evaluation is assumed to be protective of the larger ecosystem. The use of bioassays as indicators for larger groups of organisms has a strong historical precedent. Most of the EPA water quality criteria used to protect aquatic life in the U.S. has been derived directly from water-column bioassays conducted on sensitive species.

Response for use of major taxa: Although patterns based on species abundances were analyzed and discussed in the remedial investigation, major taxa were selected as the indicators of benthic effects for several reasons. First, abundances of major taxa generally exhibit less variability than species abundances and therefore are more amenable to impact determinations based on statistical criteria. Second, the use of major taxa avoids many of the uncertainties associated with interpreting the causes and significance of subtle shifts in species abundances at different locations. Finally, it was assumed that large reductions in the abundances of species groups (i.e., those species pooled within each major taxon) would be more meaningful ecologically than reductions in the abundances of single species. Although different species may exhibit variable responses to different kinds of environmental pollution, several investigators (Pearson and Rosenberg 1978; Rygg 1985, 1986) have suggested that most taxa will exhibit reductions in abundance in response to chemical contamination. Use of major taxa as an indicator should therefore reflect the patterns of abundance of most species.

3.2.2. Non-toxic effects can bias the biological indicators used to assess toxic effects. For example, low dissolved oxygen may bias results of the bivalve larvae abnormality test and sediment grain size may affect results of the amphipod mortality test.

Response for bivalve larvae abnormality test: Low concentrations of dissolved oxygen (i.e., <4 mg/L) were found in the test chambers for the bivalve larvae abnormality test for six stations in Commencement Bay. Several commenters suggested that the observed abnormalities at these stations may have been due to the low levels of dissolved oxygen rather than to chemical toxicity.

The potential confounding effects of low concentrations of dissolved oxygen at the six stations were discussed in the remedial investigation. Significant ($P<0.05$) values of abnormality were found at all six stations. To be environmentally protective, the significant abnormalities were attributed to chemical toxicity, rather than low levels of dissolved oxygen. The assumption that chemical toxicity was largely responsible for the observed values of abnormality was supported by results based on the other biological indicators and sediment chemical concentrations. Significant ($P<0.05$) amphipod mortality was found at four of the six sites, and significant depressions in the abundances of major benthic macroinvertebrate taxa were found at all six sites. In addition, concentrations of various chemical contaminants were greater than 100 times the levels found in reference sediments at all six sites.

Response for amphipod mortality test: The amphipod test does not display high mortalities in CB/NT sites with low levels of sediment contamination that would indicate substantial effects due to particle size. DeWitt et al. (1988) have demonstrated that sediments having a high percentage of fine-grained material can cause mortality in the amphipod test in the absence of chemical contamination. Several commenters suggested that the effects of sediment grain size may have confounded the results of the amphipod mortality tests and resulted in erroneous impact designations.

The potential confounding effects of sediment grain size in the amphipod test was acknowledged in the remedial investigation. However, the effects of grain size are highly unpredictable. In the reference-area database used by DeWitt et al. (1988), mortality ranged from 0 to 70 percent at values of percent fine-grained sediment greater than 70 percent. The considerable scatter in the data resulted in a regression relationship that, while significant ($P<0.05$), could explain only 29 percent of the variability. Given this uncertainty, all test results judged significant ($P<0.05$) in the remedial investigation and AET database were considered the result of chemical toxicity. This approach ensured that all impact designations were environmentally protective.

The reliability of the amphipod data in detecting contaminant effects is further substantiated by the general concordance with other bioassay tests, infauna analyses, and by the high degree of sediment contamination typically present at CB/NT sites that displayed significant amphipod toxicity.

3.2.3. *Toxicity and biological indicators show inconsistencies in defining impacted areas.*

Response: A number of differences were found among the biological indicators with respect to the stations identified as impacted and not impacted. Several commenters suggested that because the indicators were not in perfect agreement, they were not meaningful.

Different species commonly exhibit substantial differences in sensitivity to chemical contaminants. In addition, different life stages (e.g. larval, juvenile, adult) within a species frequently show variable sensitivities. It therefore is not surprising that differences among indicators were found with respect to impact designations. Multiple biological indicators were used in the remedial investigation and AET database specifically because of the different sensitivities expected among species and life stages. It was recognized that no single indicator could be considered representative of all the organisms present in the CB/NT ecosystem. By using multiple indicators, contaminated areas could be evaluated using a preponderance-of-evidence approach.

Notwithstanding the acknowledged differences among the biological indicators, overall agreement of test results was relatively high. Williams et al. (1986) found a significant correlation ($r=0.86$, $P<0.001$) between the results of the amphipod mortality and bivalve larvae abnormality tests. Becker et. al. (1987) found that concordance of impact designations based on the bivalve larvae abnormality test and the three kinds of major benthic taxa (i.e.. *Polychaeta. Mollusca. Crustacea*) ranged from 68 to 76 percent and were significant ($P<0.05$. binomial test) in all cases. Concordance between the results of the amphipod mortality test and the major taxa was somewhat less (59-62 percent) and not significant ($P>0.05$) in any instance. These results suggest that the biological indicators used in the remedial investigation and AET database were in general agreement with respect to impact designations. but that indicator-specific differences were also present. Therefore. the use of multiple indicators resulted in general substantiation of adverse effects in high priority areas while also ensuring the detection of effects due to species-specific factors in contaminant sensitivity or exposure route.

3.2.4. *Use of statistical criteria to define impacts may be inappropriate.*

Response: A primary criterion in selecting the biological indicators used in the CB/NT remedial investigation and the AET database was ecological relevance. Benthic macroinvertebrate assemblages were selected because they are a critical link in detrital-based ecosystems for energy transfer to higher trophic levels (e.g., larger invertebrates and fishes). In addition, because these organisms are relatively stationary and live in close association with bottom sediments, they represent an ecosystem component with one of the highest risks of being affected by sediment contamination. It was therefore assumed that evaluations based on benthic macroinvertebrate assemblages would be protective of most of the remaining ecosystem in the bay.

Sediment bioassays were used in the remedial investigation and the AET database because they allowed an evaluation of sediment toxicity under controlled laboratory conditions. To ensure that the bioassays used in the remedial investigation and AET database were ecologically relevant, the test species were selected on the basis of their presence in Puget Sound and their sensitivity to contamination. Both the amphipod *Rhepoxynius abronius* (used in the amphipod mortality test) and the Pacific oyster *Crassostrea gigas* (used in the bivalve larvae abnormality test) are members of the Puget Sound ecosystem. In addition, both are considered relatively sensitive to chemical contamination and are therefore representative of the ecosystem components most likely to be affected by sediment contamination. It was therefore assumed that evaluations based on these bioassays would be protective of the larger ecosystem.

Statistical criteria were used in the biological evaluations because they allowed explicit hypotheses related to impacts to be tested in an objective manner, and with a known degree of confidence. The use of statistical criteria removed much of the potential subjectivity involved in determining whether a biological effect was important. Although ecological relevance was not addressed directly, it was considered indirectly by the choice of biological indicators. In addition, the magnitude of effects determined to be statistically significant were large enough to be considered ecologically important. For the two sediment bioassays, effects (i.e., amphipod mortality and oyster larvae abnormality) were generally found to be significant when responses were found in more than 25 percent of the test organisms. For the benthic macroinvertebrate analyses, effects were generally determined to be significant when organism abundances were less than half the values observed in reference areas. Therefore, the statistical tests used in the remedial investigation did not result in the detection of very small changes in toxicity or benthic abundance.

Impact designations and biological test procedures described in the Record of Decision will continue to be adjusted in accordance with changes in Puget Sound Estuary Program protocols. These changes may result in 1) changes in the AET database, 2) changes in test evaluation procedures, or 3) replacement of any of the three biological indicators by more appropriate tests, as described in Section 8.2.5 of the Record of Decision.

3.3. Comments Related to Cleanup Goal for Environmental Protection

3.3.1 The cleanup goal of "no acute or chronic adverse effects on biological resources" represents pristine conditions in an area that is an active port. For the remedial action evaluation criteria, the apparent goal of converting the waterways to the conditions of unindustrialized deep aquatic environments is inconsistent with their original condition as mudflats and the reality of their current use by industry. An achievable and sustainable sediment cleanup objective and standard should be established before implementing sediment remediation.

Response: The goal of the CB/NT project is not to restore the environment that predated man's arrival in Commencement Bay. The goal of the project is to ensure that the environment is not acutely toxic to organisms that would ordinarily inhabit it and does not pose significant human health risks, as mandated by Superfund regulations and allows for the continuation of the native American fishery as mandated by treaty. The cleanup goal represents conditions that currently exist in urban and nonurban areas of Puget Sound (including parts of the CB/NT site), not pristine conditions. As stated in the Record of Decision (see Section 7), the long-term cleanup objective represents chemical concentrations that are well above reference area concentrations. Moreover, the reference conditions used to discriminate adverse biological effects for the remedial investigation and AET database were not based on pristine conditions.

The reference areas used for sediment bioassays have included nonurban embayments such as Carr Inlet, Port Susan, and Sequim Bay. Although these embayments are not influenced by major sources of chemical contamination, none of them can be considered pristine because of other local human impacts and indirect contamination at low levels via air and water circulation throughout Puget Sound. The closest approximation to pristine conditions used for the sediment bioassays are the sediment samples from West Beach on Whidbey Island and clean seawater that are used as negative controls for the bioassay testing. Because these controls are only used to determine the acceptability of bioassay results, they do not directly influence the determinations of cleanup objectives.

The reference areas used to evaluate adverse effects on benthic macroinvertebrates have included Blair Waterway (in Commencement Bay), Blakely Harbor, Carr Inlet, Port Susan, and central Puget Sound off Seahurst in West Seattle. As with the bioassay reference areas, none of the reference areas used to determine benthic effects can be considered pristine. This is particularly true for Blair Waterway, which was used as a fine-grained reference area for stations in other Commencement Bay waterways as part of the remedial investigation.

3.3.2. There is no adequate assessment of chronic effects in the AET values used in the feasibility study for assessing environmental risk.

Response: Reliance on acute responses (i.e., acute toxicity bioassays) to generate sediment quality values may not be protective of all chronic health impacts to aquatic organisms. Although AETs could be developed based on results of chronic laboratory tests, standardized tests to assess chronic adverse effects associated with sediment contamination were not available for the feasibility study. By necessity, AETs were developed using available biological indicators, and the sediment quality objective for the CB/NT site recognizes this practical limitation. The generation of AET values based on a variety of sublethal and lethal biological indicators does, however, address many complex biological-chemical interrelationships. The various biological tests used to generate AET values use sensitive species and are therefore representative of ecosystem components that are most likely to be affected by sediment contamination. These indicators include benthic infauna analysis that incorporates a measure of both *in situ* chronic and acute effects. These effects could include, for example, chronic toxicity to all life stages, behavioral changes, reproductive alterations, tumor inductions, and altered predator-prey relationships. For the CB/NT site, a significant response according to any one of the three acute biological indicators will be used as a criterion for presumptive harm during the cleanup phase because not all possible biological effects have been measured.

In addition to toxicity from measured contaminants, the AET approach also incorporates the net effects of the following factors that may also be important in field-collected sediments:

- Interactive effects of chemicals (e.g., synergism, antagonism, and additivity)
- Unmeasured chemicals and other unmeasured, potentially adverse variables
- Matrix effects and bioavailability (i.e., phase associations between contaminants and sediments that affect bioavailability of the contaminants, such as the incorporation of polycyclic aromatic hydrocarbons (PAH) in soot particles).

The AET approach cannot distinguish and quantify the individual contributions of interactive effects, unmeasured chemicals, or matrix effects in environmental samples, but AET values may be influenced by these factors. Only laboratory-spiked sediment bioassays offer a systematic and reliable method for identifying and quantifying these complex interactions. A great deal of research effort would be required to test the range of chemicals potentially occurring in the environment (both individually and in combination), a sufficiently wide range of organisms, and a wide range of sediment matrices to establish definitive criteria. The AET approach has an advantage over single chemical spiking studies because it incorporates the influence of these factors in the generation of AET values from field data.

4. THE APPARENT EFFECTS THRESHOLD APPROACH

Although the sediment quality objectives for the CB/NT site are defined according to three biological indicators and human health risk assessments, AET values developed for Puget Sound have been used as the primary technical basis for establishing chemical-specific sediment cleanup objectives relative to environmental protection at the CB/NT site. Three major kinds of comments with respect to use of the AET approach were received. They include questions concerning 1) the conceptual basis of the AET approach, 2) appropriate generation of AET values, and 3) appropriate regulatory applications of AETs in making cleanup decisions. Major issues related to these comments are addressed in this section.

The AET approach was supported as the best method available at the present time to identify sediments requiring remedial action or to estimate chemical concentrations associated with harm to marine life by Ecology, Washington Department of Natural Resources, PSWQA, the Commencement Bay Citizens Advisory Committee, the Sierra Club, and the NOAA Oceans Assessment Division. Various concerns over conceptual aspects of this approach were advanced by the Commencement Bay Group, the city of Tacoma, Foss Maritime, Kaiser Aluminum and Chemical Corporation, Manke Lumber Company, Pennwalt Chemical Corporation, and the Washington Department of Natural Resources. The Commencement Bay Group also proposed ecologically significant benthic effects AET be used as an alternative guideline for sediment assessment.

It was noted that site-specific biological data used to generate AET values were not available at every station sampled at the CB/NT site. Superior Oil Co. requested confirmation of chemical predictions prior to determining the need for sediment remediation. Regulatory issues raised by the city of Tacoma, Martinac Shipbuilding, Port of Tacoma, and Tacoma-Pierce County Chamber of Commerce included questions on the relationship of AET values used in the CB/NT feasibility study to proposed state sediment standards and whether AETs were being used to establish a goal of pristine conditions in Commencement Bay (this latter comment has been addressed in Section 3.3).

4.1 Comments on Conceptual Basis of the AET Approach

4.1.1. The AET approach does not provide an appropriate cleanup standard because AET values are strictly predictions of correlations, and fail to prove cause-effect relationships between contaminants and biological responses.

Response: This concern applies in practice to all sediment quality values available because none (including spiked sediment bioassays) can provide proof of cause-and-effect under actual field conditions. Research to assess the correspondence of AETs to toxicological studies has been recommended and is underway to a limited extent. However, cause-effect proof of harm is not required under Superfund to be included in the decision-making process at the national priority list sites. In the interest of protecting human health and the environment, Superfund law and guidance requires timely decisions and actions based on the best information available. Therefore, the potential for adverse biological and human health effects is sufficient to pursue regulatory actions at the CB/NT site. Proposed actions utilize a preponderance of evidence of the association of chemical contamination and adverse biological effects in assessing cleanup levels. The problem chemicals identified by the AET approach at a particular problem area represent a best effort to discern between measured chemicals that do not appear to be associated with adverse biological effects and those that do. In addition, because all potential contaminants cannot be measured routinely, cleanup strategies must also rely to some extent on the regulation and management of "surrogate" chemicals. If, for example, an unmeasured chemical (or group of chemicals) varies consistently in the environment with a measured chemical, then the AETs established for the measured contaminant will indirectly apply to, or result in the management of, the unmeasured contaminant. In such cases, a measured contaminant would act as a surrogate for an unmeasured contaminant (or group of unmeasured contaminants).

The correlative evidence of the AET approach in Puget Sound is based in part on field data on chemical contamination in CB/NT areas that evidence adverse biological effects by multiple indicators. The chemical contamination in many of these areas has been associated with particular sources both by chemical composition and by spatial distributions. This preponderance of chemical and biological evidence is judged to be sufficient in high priority areas considered in the feasibility study. Because strict cause-effect relationships are not proved, the AET approach is used as only one tool that guides the overall decision-making process. This protective assumption can be confirmed by optional site-specific biological testing in the remedial design phase.

4.2 Comments on the Application of the AET Approach for Decision-Making

4.2.1. The AET approach is used to establish cleanup goals solely on the basis of predictive capabilities. Confirmation of results is necessary before proceeding with cleanup. The approach should be used as a guideline rather than a strict standard.

Response: CB/NT sediment quality objectives are defined according to biological test results. The AET database is used only as a tool for predicting levels of chemical contaminants above which adverse effects would be measured using those tests. However, confirmation of chemical predictions using biological testing has been established as an option during the remedial design phase. The results of such site-specific testing would outweigh the AET prediction of biological effects and therefore determine the final action to be taken. Therefore, the AET approach is not being used as a strict standard for required sediment cleanup, only to provide a basis for estimating potential cleanup volumes of sediment. This application of biological testing and the AET database is similar to that used in other Puget Sound programs such as PSDDA, the Puget Sound Estuary Program, and emerging state standards and regulations.

4.2.2. Use of AETs is particularly questionable in intertidal areas.

Response: The different contaminated matrices to which AETs have been applied in the subtidal environment represent a broader range in matrix type, and associated variations in bioavailability, than do differences between subtidal and intertidal environments. Based on this consideration and preliminary reliability results for tests involving AET application to intertidal sediments, existing AET values have been recommended for use in identifying potential problem areas at intertidal stations in Puget Sound (Becker et al. 1989). Ongoing review of any additional verification data is also recommended. The sediment quality objective at the CB/NT site is based on biological test results that have been interpreted relative to conditions at suitable reference stations. Until further data can be evaluated, it may be appropriate for final remedial action decisions to rely on site-specific testing rather than the AET predictions in intertidal areas of the CB/NT site.

4.3. Comments Related to Chemical-Specific AET Values

4.3.1. In generating AET values, all effects are attributed to single chemicals although other factors could be relevant: water depth, turbulence, salinity, sediment texture can affect benthic abundance (and sometimes toxicity) and are not adequately addressed.

Response: The AET approach attempts to distinguish patterns of natural variability from those indicating toxic impacts by statistically comparing sample responses to reference benthic samples that have similar grain size distributions and are collected at similar water depths. This statistical comparison reduces the potential for habitat-related factors to confound the results or mask apparent relationships. The relationships observed between certain chemicals and benthic effects cannot be explained solely by habitat. In cases where potentially anomalous habitat variations and sediment toxicity could contribute to the statistical differences noted, the condition was protectively defined as an adverse biological impact.

This protective assumption can be confirmed by optional site-specific biological testing in the remedial design phase.

4.3.2. AETs fail to quantify the extent of adverse effects . . . The AET derivation process treats all statistically significant changes as equally adverse, without regard to their nature, magnitude, or ecological importance.

Response: AET values are designed to predict adverse effects that can be statistically distinguished from reference conditions. This magnitude of adverse effect is consistent with the need to address feasibly a long-term cleanup goal of no adverse effects. The magnitude of effect above this threshold is not directly taken into account in a single AET value but the range of AET values from lowest AET to highest AET for a range of biological indicators does provide a preponderance of evidence of different kinds of adverse effects. Of the 201 benthic infauna stations and 287 amphipod bioassay stations evaluated for 13 Puget Sound embayments with the AET approach (including Commencement Bay), approximately 85 percent (174 stations and 243 stations, respectively) are in accordance with the predictions of the 1988 AET values for these indicators (i.e., they do not exhibit adverse effects at chemical concentrations less than the AET values, and do exhibit adverse effects at chemical concentrations above the AET values) (U.S. EPA 1988). The reliability of AET values for the oyster larvae indicator was even higher, but only data for Commencement Bay were available for analysis. Therefore, the analysis correctly identifies impacted stations using several kinds of bioassessment techniques that employ different endpoints. These biological tests use sensitive species and are therefore representative of ecosystem components that are most likely to be affected by sediment contamination (see additional discussion in response to Comments 3.2.1 and 3.3.2). Sediment quality values that would focus only on severe adverse effects, or would otherwise be influenced by the magnitude of adverse effect that exceeded reference conditions would be less sensitive in identifying many of these measurable impacts than the AET values used at the CB/NT site.

4.4. Comments on the Establishment of AET Values for the CB/NT Site

4.4.1. Operationally, the AET is a concentration at which no effect occurred, not the concentration above which effects are always expected. Define AET as the contaminant concentration above which effects were always observed in the data set for which AET was derived.

Response: This precise definition is appropriate in order to be environmentally protective and has been incorporated.

4.4.2. [T]he goal for the cleanup [should] be defined based on what is necessary to protect human health and the environment from significant adverse impacts . . . cleanup should only be required in areas where an ecologically significant (not statistically significant) benefit can be shown.

Response: ENSR (1989) proposed a variation of the sediment quality goal by defining an ecologically significant benthic effects AET. This measure was defined as the occurrence of significant benthic infaunal depressions in more than one major taxonomic group (i.e., two or more depressions among Mollusca, Crustacea, and Polychaeta). The agencies had considered a similar measure during the development of approaches to sediment quality values, which was termed the "severe effects benthic AET," and was defined as the sediment concentration above which statistically significant benthic infaunal depressions occurred in more than one major taxonomic group (i.e., two or more depressions among Mollusca, Crustacea, and Polychaeta) (PTI 1989). This measure, and the ENSR (1989) measure were not considered to be adequately protective for mitigating environmental risk at the CB/NT site.

4.4.3. AET values should be adjusted to include safety factors for unmeasured chronic effects.

Response: Incorporation of safety factors to adjust AET values downward was evaluated (Tetra Tech 1986). The use of a safety factor of 10 as representative of an acute-to-chronic ratio (EPA 1985) recommended in water quality criteria guidance has also been evaluated (PTI 1989). In both cases, the number of correctly predicted stations exhibiting adverse biological effects increased slightly. However, there were a number of stations that did not exhibit significant adverse biological effects but were predicted to have adverse effects by AET that incorporated a safety factor. These stations may have exhibited chronic effects that were not measured. However, the evaluation suggested that incorporation of safety factors would reduce the ability to discern measurable effects from reference conditions and therefore safety factors were not recommended in the feasibility study or selected in the Record of Decision.

4.4.4. Large data sets are required to establish AET values and no minimum requirements for an acceptable data set for deriving AET have been established. The number and distribution of effect stations and the size and distribution of the total data set should be considered in interpreting uncertainties with AETs.

Response: Minimum requirements for deriving AETs were addressed by recommendations set forth during the refinement of AET values through incorporation of data from multiple Puget Sound studies (Barrick et al. 1988). This expanded database of approximately 330 stations from 13 embayments of Puget Sound (including Commencement Bay) was used to establish AET values that were used during the CB/NT feasibility study. It was recommended that at least 30 and preferably 50 stations be used to establish AET. However, a small number of stations that is representative of the range of chemical concentrations and biological responses in a region may be as or more effective in establishing reliable AET values as using a large database that is not representative of environmental conditions.

The effect of "weight of evidence" for different AET values based on the size and distribution of the total data set is one means of assessing uncertainty. Unquestionably, there is less uncertainty for an AET based on many observations than for an AET based on few observations. This is the reason that revised AETs based on a larger database than available during the remedial investigation, and with wide-ranging chemical concentrations, were incorporated into the feasibility study. Uncertainty ranges for AETs defined as the concentration range from two or three non-impacted stations below the AETs to one biologically impacted station above the AET have been evaluated based on statistical classification arguments (Tetra Tech 1986). The number of stations used to establish an AET (i.e., weight of evidence) could have a marked effect on this uncertainty range, because small data sets would tend to have less continuous distributions of chemical concentrations than large data sets. That is, small data sets would tend to have larger concentration gaps between stations (and correspondingly wider uncertainty ranges for AET) than larger data sets.

4.5. Comments on the Relationship of AET to Human Health

4.5.1. AET cannot address human health risk because they do not account for bioavailability of toxicants in situ and do not establish causality. AET cannot address bioavailability of chemicals in situ (although other commenters recommended that AET values for hydrophobic organic chemicals be normalized to organic carbon content to address bioavailability).

Response: AETs are not used as the sole basis for addressing human health risk in the feasibility study. A PCB bioaccumulation AET was assessed during the feasibility study but was not used as the sole method for selecting areas for remediation because of uncertainties in its derivation. The cleanup of sediment to reduce the risks to human health from the consumption of edible fish tissue was addressed using equilibrium partitioning principles. AET do address bioavailability of chemicals in sediments because AET values are established based on observed biological effects in field samples. AET normalized to the organic carbon content of sediment, presumed to be a major factor controlling the bioavailability of contaminants, have also been generated. The reliability of organic carbon-normalized AET values in correctly identifying adverse biological effects is approximately the same as that of dry-weight normalized AET values (U.S. EPA 1988). Dry-weight normalized AET values were used in assessing cleanup volumes of sediment because there was no direct evidence of an improvement in the ability to correctly predict adverse biological effects using organic-carbon normalized AET, and dry-weight normalized AET require less manipulation for application by regulators and potentially responsible parties (i.e., can be directly compared to chemical concentration data routinely reported by laboratories).

5. SOURCE LOADING ESTIMATES

Source identification and characterization (i.e., loading estimates) were performed based on historical data and data generated by sampling and monitoring during the remedial investigation/feasibility study process. These data were used for defining source control priorities and strategies. Most of the comments received on source identification and loading were criticisms that identification and loading estimates were incorrect or inadequate and based on incorrect or insufficient data, and that loading estimates were incorrectly calculated. In addition, several commenters stated that source characterization and identification was strongly biased toward sources for which there are data available (i.e., other potentially significant sources such as nonpoint sources may be important but are poorly characterized). The majority of the comments received were from the Commencement Bay Group (including many major PRPs).

Simpson Tacoma Kraft, Washington Department of Transportation, Louisiana-Pacific, Kaiser Aluminum, General Metals, and ASARCO all commented that source data relating to their facilities and operations are outdated or inadequate for decision-making. Griffin Galbraith, Foss Maritime, General Metals, Dunlap Towing, and USG stated that nonpoint sources are inadequately characterized and may contribute significantly to contamination. Louisiana-Pacific stated that loading data are not properly calculated. The Puyallup Tribe of Indians commented that the feasibility study should present a detailed stormwater control plan.

5.1. Comments on Identification of Present and Historical Sources

5.1.1. Characterization of PCB loading is inadequate to identify sources or support remedial action.

Response: PCB source identification was noted to be incomplete in the CB/NT remedial investigation/feasibility study and the integrated action plan. Additional source identification and monitoring activities are being conducted by Ecology, as described in the Record of Decision. The implementation section of this Record of Decision emphasizes that the acceptability of source identification and control will be reevaluated before sediment remedial actions are required.

5.1.2. Existing or historical contaminant loading is inadequately characterized.

Response: The loading data limitations were stated in the remedial investigation and feasibility study. Because of these limitations, source identification was also based on known use of problem chemicals, documented historical and ongoing disposal practices, and proximity of sediment contamination to suspected source. In addition, source loading data were not used to determine the need for or effectiveness of source controls, or to develop sediment recovery scenarios, or to allocate responsibility among PRPs.

An accurate characterization of historical loading of contaminants was not possible because few studies were conducted in the past, and those studies that were conducted did not generally address contaminants of concern. Where possible, sediment core profiles were interpreted to determine if loading has increased (characterized by a broad surface sediment maxima) or decreased (characterized by a surface sediment minima).

Loading data limitations, noted early in the study, triggered a number source characterization studies. However, not all discharges are given equal weight in terms of focusing additional source identification and control activities, or conducting monitoring studies. For example, it is not considered cost-effective to monitor drains that serve small areas where historical or ongoing activities within the drainage basin are unlikely sources of problem chemicals. Similarly, it is inappropriate to sample all discharges to a waterway if there is compelling evidence indicating a probable source or sources.

5.1.3. How will new information on sources be incorporated into the decision-making process?

Response: New data collected from ongoing or future monitoring programs will be incorporated as they become available. After signature of the Record of Decision, Ecology will continue to identify CB/NT sources, select appropriate source control measures, and enforce those measures. Several factors will be considered in this evaluation including the possibility of unidentified major sources within the problem area, the status of source control for known major sources, and the possible cumulative effects from other CB/NT sources. New information on previously unidentified sources and contaminants will be evaluated by EPA during the remedial design phase and integrated into the remedial design sampling and analysis strategy for each problem area.

5.2. Comments on Adequacy of Nonpoint Sources Relative to Point Sources

5.2.1. There is inadequate consideration of non-point sources of pollution, including the potential impact of recontamination from continuing sources.

Response: This comment refers to nonpoint source contamination that is generally discharged to Commencement Bay via storm drains. Storm drains are included as potential sources to Commencement Bay and can be regulated as point sources, although they may represent contributions from nonpoint sources of contamination. However, not all storm drains are given equal weight as potential problem sources (see Response 5.1.2). The factor that street dust exceeds target cleanup levels does not indicate that urban runoff is a major source of contamination to Commencement Bay. To determine the impact of street dust (or similar material contributed by runoff) on the marine environment, several factors are considered: 1) the types of contaminants present in the street dust, 2) processes influencing the fate and transport of contaminants in street dust on the way to the marine environment, 3) the rate at which street dust (or related contaminants) are supplied to the marine environment relative to other sources of the same contaminants, and 4) the ability of the receiving environment to assimilate (or dilute and disperse) the total contaminant load. Ecology is responsible for evaluating these factors and developing permits for storm drains under the Clean Water Act and the PSWQA plan. New information from other studies regarding airborne emissions and other nonpoint sources that are not incorporated into storm drain permits will also be evaluated by the appropriate federal, state, or local agency.

5.2.2. A storm drain control plan should be developed before the Record of Decision is finalized. Without a remedial investigation/feasibility study and a Record of Decision for source control, potentially responsible parties cannot obtain CERCLA resolution of Superfund liability.

Response: For problem areas where storm drains have been identified as a significant ongoing source, storm drain control plans must be implemented before sediment remedial action can proceed. A detailed storm drain control plan can be considered an element of remedial design, and does not need to be finalized before the Record of Decision.

5.3. Comments on Loading Calculations

5.3.1. Loading calculations are incorrect and statistically invalid.

Response: Loading calculations were conducted by averaging available concentration data and flow data, and multiplying the two averages to arrive at the loading rate. The correct procedure is to first multiply data pairs, and then time average data pairs. The former procedure was applied to CB/NT data because synoptic data for concentration and flow were often not available. This simplified procedure introduces a great deal of uncertainty into the loading estimate for sources that display a great deal of temporal variability. As noted earlier (Comment 1), limitations in the loading data were clearly noted in the remedial investigation/feasibility study. Source loading estimates will be refined during source monitoring, and the relationship of source loading to sediment accumulation will be examined in greater detail during sediment remedial design sampling.

It was noted that by not using undetected values for chemical measurements, loading calculations result in overestimates of the discharge load. This is only correct if 1) detection limits for chemicals are well below measured values, and 2) loading values from paired data that are based on detection limit values are less than loading values based on detected values. (It is assumed that paired flow and concentration data are first combined to estimate loading for discrete points in time; the correct technique described above.)

It was argued that loading data are statistically invalid because the EPA Test Method for evaluating solid waste, SW-846, suggests that the variance of the test data should be less than the average mean concentration. This guideline, while appropriate for solid waste, may not be appropriate for storm drain sampling programs where extreme amounts of data would have to be collected to characterize the highly variable flow and loading conditions. However, EPA and the state encourage the collection of comprehensive loading data where resources permit.

5.3.2. There are problems with the source loading database, especially at concentrations below EPA method detection limits.

Response: Data reported at levels below EPA method detection limits may or may not be incorrect. Modified analytical techniques are sometimes used to quantify below these limits based on specific project requirements. Such modifications are typically documented in sampling and analysis plans and quality assurance project plans. However, in some cases, particularly with older data sets, false positive values are of concern. In these cases, source loading data should not and will not be used a the sole basis for identifying a potential source. Rather, chemical usage and disposal practices will be evaluated.

6. SOURCE CONTROL

Source control and sediment remediation are two key components of site cleanup. Source control is important for preventing ongoing degradation, enabling natural recovery, and preventing recontamination of remediated areas. Comments received on source control focused on three themes: the emphasis placed on source control, the feasibility and effectiveness of source control, and source loading estimates.

TPCHD, the Washington Department of Natural Resources, and Puget Sound Plywood commented that the feasibility study should place more emphasis on source control and the PSWQA stated that the integrated action plan should address spills and spill prevention. The Tacoma-Pierce County Chamber of Commerce expressed concern over the fact that areas outside the CB/NT site are not addressed and should be monitored by EPA and Ecology. The Puyallup Tribe of Indians stated that source control should be implemented immediately and considers the feasibility study inadequate to assess source control needs.

6.1. Comments on the Appropriateness of Source Control

6.1.1. A systematic look at all sources, their contribution, degree of achievable control, and priority for control, should be defined. The framework for such a plan should be established prior to the Record of Decision.

> **Response:** Source control is considered a key element of the site remedy; source control efforts to be conducted by the Commencement Bay UBAT has been enhanced through a Cooperative Agreement between EPA and Ecology. Control of major sources of problem chemicals to a level that utilizes all known available and reasonable methods of technologies (AKARTs) is required before sediment remedial action is scheduled to proceed. Source control at the CB/NT site is a complex process because of the large variety of sources, the various status of sources (i.e., historical, ongoing, increasing, decreasing), and the changing institutional structure of environmental standards and requirements. Consequently, source control is addressed through a variety of programs that are either being implemented by Ecology or coordinated with Ecology's Commencement Bay UBAT to ensure consistency with the objectives of the CB/NT project. These programs are described in greater detail in Section 3 of the Decision Summary and in the integrated action plan (PTI 1988) of the CB/NT feasibility study.
>
> The feasibility study focused on sediment remedial action but source control was also integrated into the overall process. General response actions for various types of source control were described, feasible levels of source control were estimated, and enhanced regulation and control of significant sources was described as a key element of all CB/NT remedial alternatives, except the No Action alternative. More specific information regarding the status and nature of major sources in each CB/NT problem area was also described. The integrated action plan was developed as a framework for scheduling and planning both source control and sediment remedial action at the CB/NT site. The timetables outlined in the integrated action plan are intended to be updated on a regular basis to reflect changes as overall project implementation proceeds. Details of source control strategies, including specific remedial technologies, are available in the various individual facility or source studies. In general, such controls require AKARTs to all point sources and rigorous application of best management practices to nonpoint sources.

6.2. Comments on Remedial Technologies for Source Control

6.2.1. The feasibility study proposes infeasible end-of-pipe source control measures. A more detailed cost evaluation for individual source control measures should be presented.

> **Response:** Source control estimates are based on existing compliance and inspection schedules as well as the best professional judgement of Ecology experts responsible for implementation of source control, and as such are adequate for planning purposes and prioritization of both sources and sediment remedial action planning. The agencies recognize that 1) source control measures must be evaluated more closely on a property-specific basis, 2) compliance schedules must also be developed on a source-by-source basis, and 3) sediment remediation cannot proceed until adequate source control is achieved.

6.3. Comments on Relating Source Control to Sediment Quality Objectives

6.3.1. The agencies first objective should be to control existing sources of pollution in Commencement Bay before requiring that industry, the city, the port, and landowners invest large sums of money in sediment remedial action.

> **Response:** Sediment remedial action will not be implemented until source monitoring confirms that major sources have been controlled to the extent that sediment recontamination is not predicted to occur, or that the source is in compliance with AKART requirements. This

determination will be made by Ecology and EPA. There may be facilities which, after implementation of AKART, continue to discharge contaminants at levels that will exceed sediment cleanup objectives in the vicinity of the source. For these facilities, a waiver will be incorporated into applicable permits to allow a temporary sediment impact zone with specified requirements for monitoring and closure.

6.4. Comments on Appropriateness of Feasibility Estimates for Source Control

6.4.1. The feasibility study overestimated the feasibility and effectiveness of source control measures.

Response: The percentage reductions estimated to be feasible were intended to be extremely rough estimates (see responses in Section 5.3). Most assumptions are conservative. For example, the reduction in HPAH release already attained by Kaiser Aluminum probably represents greater than the 90 percent reduction (relative to an assumed steady state with existing surface contamination) that was estimated to be feasible in the feasibility study. However, the effectiveness of source controls will be reevaluated during source monitoring and remedial design. For some waterways, conservative estimates of the rate of natural recovery provided in the feasibility study will be adjusted with new data and will likely have the effect of decreasing the areas or sediment volumes that will require remedial action.

6.4.2. Source control estimates in the feasibility study are based on technically unsupportable assumptions.

Response: The source control estimates developed during the feasibility study cannot be considered guidelines for source control. These estimates were developed to estimate the relative importance of source control and natural recovery, and to estimate the cost benefits associated with the consideration of natural recovery. It was necessary to use this extremely simplistic approach to estimating source control because source loading data were inadequate (see responses in Section 5.3). Specific requirements for source control, including the relationship of source loading to sediment accumulation and the role of sediment impact zones, are currently being developed by Ecology, and will be in place before sediment remedial action takes place.

6.5. Comments on the Status of Source Control

6.5.1. Recent activities and loading data indicate that many sources are controlled.

Response: It is recognized that source controls have been implemented and that their success has been documented at several facilities. This will be confirmed on the basis of source loading analyses conducted before sediment remedial design.

7. NATURAL RECOVERY AND THE SEDIMENT CONTAMINANT ASSESSMENT MODEL

The Sediment Contaminant Assessment Model (SEDCAM) was developed and applied to CB/NT problem areas to describe the relationship between source loading and sediment accumulation of problem chemicals, and to estimate the relative importance of natural recovery. Comments on SEDCAM related primarily to the model's simplifying assumptions and its lack of field verification. The Puyallup Tribe of Indians commented that SEDCAM will overestimate recovery rates because assumptions about source control. However, most commenters (primarily PRPs) stated that SEDCAM would underestimate recovery. Louisiana-Pacific, Port of Tacoma, and NOAA expressed concern over model uncertainty, the limitations to the use of the model because of inherent assumptions, and the lack of field verification.

7.1. Comments on the Protectiveness of Natural Recovery

7.1.1. Natural recovery is de facto in situ capping, but in situ capping was rejected as an alternative in all waterways but St. Paul because of the high likelihood that the sediments in all of the other waterways would be dredged for maintenance or new construction.

> **Response:** *In situ* capping was not rejected; in fact, the selected alternative identified in the Record of Decision broadly defines sediment confinement to include *in situ* capping. In natural recovery areas that may require maintenance dredging, the dredging and dredged material disposal would be regulated by Clean Water Act Sections 401 and 404 (i.e., the state water quality certification process), Washington Department of Fisheries and Washington Department of Wildlife (hydraulics permits), Washington Department of Natural Resources (aquatic disposal site permits), city of Tacoma (shoreline substantial development permits), and PSDDA (procedures and guidelines for dredged material and disposal site testing). Routine navigational dredging actions must meet all substantive and procedural requirements of these permit and certification programs.

7.1.2. The proposed natural recovery is simply a slow form of dilution. The same result, without the delay and uncertainty of recovery, would occur by allowing in situ capping.

> **Response:** In marginally contaminated areas, natural accumulation of cleaner sediment that would result in recovery over a reasonable time period was preferred to the potential adverse impacts of sediment confinement operations (e.g., burial of existing benthic communities). Natural recovery increases the feasibility of sediment remedial action by enabling resources to be focused on more highly contaminated areas, and by reducing overall costs.

7.1.3. Natural recovery should be the preferred alternative except in cases where it plainly will not protect human health and the environment in the long term.

> **Response:** Natural recovery has been determined by EPA and Ecology to be appropriate in marginally contaminated areas, because recovery can occur in a reasonable time period following source control. In more heavily contaminated areas, the predicted persistence of significant adverse impacts over long periods of time outweighs the potential short-term impacts from active remediation; therefore, sediment remediation is warranted in order to be adequately protective of human health and the environment.

7.2. Comments on Modeling Predictions Using SEDCAM

7.2.1. Simplifying assumptions limit the utility of the model.

> **Response:** The simplicity of the model, and the additional simplifying assumptions that were incorporated into its application reflect the data limitations noted earlier for source loading. Sedimentation rate, depth of the mixed layer, and chemical-specific degradation (or loss) rates (simulated as a first order process) are also poorly known. Further refinements both to the model formulation (e.g., simulation of sediment mixing with an eddy diffusion coefficient, inclusion of enhanced exchange with overlying water during sediment resuspension, formulation of a time-variable input function) and to its application (e.g., use of recently collected loading data that had undergone comprehensive data validation) will occur during source monitoring and sediment remedial design.

7.2.2. Too many conservative assumptions are included in the application of SEDCAM.

> **Response:** In the absence of adequate data, conservative assumptions were applied. It should be noted that the assumption of a 10-cm thick mixed layer translates to a comparatively nonprotective (i.e., non-conservative) cap thickness. That is, surface sediments that undergo natural recovery are considered to have attained the long term objective when chemical concentrations in the mixed layer (upper 10-cm) meet long-term objectives; however,

sediments that are not predicted to undergo sufficient recovery in a reasonable time frame are subject to burial with a 3- to 6-foot layer of clean sediments.

7.2.3. Insufficient and unreliable model input data from Commencement Bay has resulted in recovery times that may be several times longer (some commenters claim shorter) than actual recovery times. SEDCAM has not been field tested.

Response: Confirmation of model predictions with sediment monitoring data is a required element of the site remedy. Predictions regarding the effects of source control and natural recovery which were developed during the feasibility study must be refined based on new data obtained during source monitoring and sediment remedial design sampling.

7.2.4. The SEDCAM application to the Head of City Waterway used erroneous data. A sedimentation rate of 600 mg/cm^2/yr is used instead of the value of 1,760 mg/cm^2/yr indicated by the ^{210}Pb data.

Response: The commenter indicated that depth changes since last dredging indicates a sedimentation rate of 3.0-3.7 cm/yr instead of the 1.26 cm/yr indicated by ^{210}Pb or the value of 0.43 cm/yr used in the feasibility study. A lower sedimentation rate was used because existing information on the loading rate of material from the two major drains at the head of the waterway indicated much greater discharges of particulate material in the past. This change in sediment accumulation confounds interpretations of ^{210}Pb data, because the ^{210}Pb dating model assumes constant sediment accumulation (on the average) over the time period that is being dated. Similarly, if the average sedimentation rate was used (on the basis of the dredging horizon), the sedimentation rate would also be greatly overestimated.

8. SEDIMENT REMEDIAL ALTERNATIVES

Sediment remediation is one of the major components of the site cleanup. Comments regarding remedial alternatives included discussion of evaluation criteria used in the feasibility study, the feasibility and impacts of dredging, natural recovery, and monitoring requirements. Most of the comments were made by the major PRPs, both individually and together (as the Commencement Bay Group). In general, comments of the PRPs questioned the need for, and feasibility of, remedial actions.

8.1 Comments on the Permanence of Confinement Options

8.1.1 The feasibility study is clear in recognizing that none of the confinement options meet the SARA preference for a permanent solution.

Response: The remedy selected in this Record of Decision is intended to provide a permanent solution to CB/NT sediment problems. (See response to Comment 1.1.1 and further discussion in Section 11.4 of the Decision Summary regarding differences between permanent solutions and utilization of permanent treatment technologies.)

8.2 Comments on the Feasibility of Confinement Options

8.2.1. The feasibility study does not identify feasible and cost-effective disposal sites. Site-specific data are not detailed enough to identify the disposal site capacity needed and available. Disposal site bathymetry, calculated capacity, diking configuration and volume, and other geotechnical considerations are required evaluation criteria instead of specifying an unidentified upland site within a 3-mile radius.

Response: The assessment of disposal site availability will change depending on changes in alternative uses of the site and estimates of total volumes of material to be dredged as part of sediment removal action. The selected remedy includes a suite of containment options which include some with definite disposal site availability (e.g., confined aquatic disposal in waterways). All of the candidate sites in the feasibility study are located near the problem areas and represent near-minimum transportation costs. Final selection of a disposal site for each problem area is most appropriately decided during remedial design when more accurate data on sediment volumes are available.

8.2.2. The proposed remedy does not adequately take into account the lack of suitable, available onsite disposal capacity.

Response: The selected remedy includes a suite of containment options which include some with built-in disposal site availability. The options are considered equally protective and feasible. EPA recognizes that the containment option selected for each waterway will force certain economic/development choices by PRPs. The agencies do not see the need to specify disposal sites in the Record of Decision.

8.2.3. Blair Waterway Slip 1 is not available for nearshore disposal or of inadequate capacity. The Wheeler Osgood waterway, the St. Paul Waterway, and the Hylebos Disposal Site #1 are suggested as alternative sites.

Response: The comment noted that volumes cited in the feasibility study are various and overestimated even presuming a vertical wall at the outer end of the slip. A vertical wall is unreasonable, and construction of a berm would further reduce slip capacity. Capacity is estimated to be 590,000 cubic yards for a 55-foot fill and 347,000 cubic yards for a 30-foot fill. Changes in the Port of Tacoma's intended use of Slip 1 have occurred since the collection of data for the feasibility study, and it is uncertain whether this site will be available for nearshore disposal.

Nearshore disposal has been included as one of the four confinement options within the selected remedy. As a general policy for the CB/NT site, EPA would prefer that the nearshore disposal option only be utilized in conjunction with projects that would otherwise be permitted commerical development. The intent of this policy is to minimize unnecessary impact to nearshore habitat, consistent with the provisions of the Clean Water Act Section 404. Therefore, the use of these other areas as potential nearshore disposal sites would be limited according to the CB/NT policy to minimize impact to intertidal and nearshore areas.

8.2.4. The feasibility study incorporates unrealistic goals of clean sediment availability. An estimate of the quantity of capping material needed and available should be made.

Response: The volume of clean sediment required varies with the alternative. For *in situ* capping, the entire problem area must be covered with a cap of 3-6 feet in depth, or a total of 792,000-1,548,000 cubic yards. For nearshore and upland disposal, only the intertidal area must be capped (for habitat mitigation), requiring a total of 32,000-64,000 cubic yards. For in-waterway CAD, overdredged sediment will be used for capping.

8.2.5. Use of deep-water CAD is unproven, and experience suggests it will not reliably eliminate exposure of biota to toxics.

Response: Although deep-water CAD sites have effectively been used in other sites, it is not included in the selected remedy for the CB/NT site.

8.2.6. Specification of the use of new technologies in St. Paul Waterway, for which the preferred alternative is natural recovery, is not appropriate, and should not be included in the Record of Decision.

Response: No such technology is specified in the selected remedy. The remedial action undertaken in the St. Paul Waterway area by Simpson Tacoma Kraft included containment of contaminated sediments behind a berm, capping with clean material, and habitat restoration.

The proposed plan was reviewed by appropriate agencies and was implemented in a timely manner. The benefits of timely remediation, habitat restoration, and an engineered cap design that will be monitored outweighed any concerns for the use of remedial technologies over natural recovery.

8.2.7. The Record of Decision should acknowledge that the preferred alternative for St. Paul waterway (source control, a new outfall, and remedial action) has been successfully implemented.

Response: The comment is noted. The Record of Decision includes a description of cleanup activities completed in St. Paul Waterway.

8.2.8. The feasibility study did not identify feasible dredging technology for the Ruston-Pt. Defiance Shoreline.

Response: The Ruston-Pt. Defiance Shoreline has been removed from the list of problem areas to be addressed by this Record of Decision.

8.2.9. Some areas to be dredged are under piers; the feasibility study does not identify feasible or cost-effective remediation techniques for these and other obstructed areas. The comment noted that the side slopes of Sitcum Waterway are covered with riprap; alternatives for removal are costly and pose a risk to existing pier structures.

Response: The extent of contamination of each problem area will be further evaluated during sediment remedial design. If sediment problems are indicated in areas such as side slopes, under piers, and in other obstructed areas, special remediation techniques may have to be developed to meet the performance-based criteria. Alternative technologies, including those not commonly used in Puget Sound, such as mud cats, may be applied in pier areas; *in situ* capping may also be selected as an alternative to sediment removal. However, remedial action in areas covered with riprap is unlikely except perhaps if it is a component of a source control action.

8.2.10. The feasibility study does not identify feasible or cost effective remedial alternatives for the head of Hylebos Waterway. The feasibility study recommended dredging and confined aquatic disposal at the mouth of the waterway, and dredging and nearshore disposal for the head, at approximately 3 times the estimated cost of confined aquatic disposal.

Response: The selected remedy has been modified to address such concerns. The remedy selected in this Record of Decision specifies a range of containment options as the sediment remedial action element rather than specifying a performance-based remedy or a single containment alternative.

8.3 Comments on the Impacts of Dredging and Disposal

8.3.1. Remedial dredging destroys benthic habitat, resuspends sediment, and releases toxins.

Response: Remedial dredging is to be conducted in areas in which the habitat has already been degraded beyond its ability to support a healthy benthic community as measured by objective statistical analysis of *in situ* abundances of benthic macroinvertebrates. In-waterway confined aquatic disposal will result in the disturbance and burial of existing communities, but the clean material to be used for capping will provide habitat for the reestablishment of a healthy benthic community. Use of a modified, watertight clamshell dredge and a hydraulic dredge will reduce resuspension of sediments and release of toxics to the maximum extent practicable.

8.3.2. Nearshore disposal must adhere to the policy of no net loss of wetland habitat.

Response: Nearshore disposal has been adopted as one option for confinement. The selection of an appropriate nearshore disposal site (if appropriate), and the protection of wetland habitat, must be considered during the remedial design for each problem area. Nearshore disposal is only considered appropriate if it can be incorporated with an approved development project.

8.3.3. Concentration data used for establishing preferred alternatives (particularly for the turning basin at the head of Hylebos) are outdated immediately by the bottom disturbance caused by vessels.

Response: The proximity of sediment contamination to suspected or identified sources suggests that sediment reworking does not disperse contaminated sediment over large geographic areas. Sediment sampling during remedial design will determine the extent of sediment redistribution at the head of Hylebos Waterway. This effort will include sampling at depth in sediment cores to characterize the entire volume of material requiring remediation.

8.4. Comments on Cost and Volume Estimates

8.4.1. The feasibility study consistently underestimates costs as a result of underestimating the sediment volumes due to swelling and overdredging; underestimation of unit costs for dredging, transportation, and disposal; omission of costs for habitat mitigation, water column monitoring, site preparation, mobilization/demobilization costs related to equipment type, and predesign sediment monitoring; underestimation of monitoring costs; omission of source control costs; omission of economic costs of dredging in active waterways, and omission of economic costs of limitations on use of nearshore areas due to structural composition of dredge spoil.

Response: Several commenters presented alternative site-specific costs for the problem areas, with a total cost almost three times as high as in the feasibility study. Revised cost estimates were conducted for the four confinement options selected in the Record of Decision, and are presented in Section 10.4 of the main text.

8.4.2. Dredging volumes specified in the feasibility study are underestimated. The need for overdredging to excavate to the depths specified in the feasibility study will increase dredged material volume. Swelling, spreading, and mounding of dredged material will also increase the volume of material to be disposed.

Response: Volume estimates were based on a four-foot dredging lift. As contaminated sediments are generally confined to the upper one to three feet, volume calculations based on the removal of a four-foot lift incorporates an overdredging allowance. Swelling of sediments is an effect not accounted for in the comparison of alternatives and preliminary cost analysis presented in the feasibility study. Swelling has its principal effect on transportation cost; sediments are expected to recompact upon disposal. Alternative volume estimates presented by commenters neglected sediment recompaction. This was accounted for in the revised cost estimates provided in the Record of Decision. The actual extent (and thus volume) of each problem area will have to be further refined during remedial design, based on additional sampling.

8.4.3. The bottom topography of the confined aquatic disposal site is sloping rather than flat, and diking may not be feasible. Dike construction may consume most of the stated capacity of the confined aquatic disposal site.

Response: New information regarding the Brown's Point confined aquatic disposal site proposed in the feasibility study does suggest that it would be unsuitable. Use of the Brown's Point confined aquatic disposal site, however, is not among the preferred alternatives identified in the final Record of Decision due to concerns regarding the ability to accurately place and monitor contaminated sediments at great depth, and due to conflicts with the CERCLA preference to avoid offsite disposal of untreated wastes.

8.5 Comments on the Cost-Effectiveness of Sediment Remedial Action

8.5.1. The performance-based Record of Decision must identify feasible and cost-effective remedial actions, not simply specify cleanup standards.

Response: Although based on performance objectives, the CB/NT Record of Decision specifies confinement as the preferred disposal alternative for contaminated sediments, including four options (i.e., *in situ* capping, confined aquatic disposal, nearshore disposal, and upland disposal). Each of these options has proven feasible and cost-effective at other sites. The inclusion of disposal options in the Record of Decision allows PRPs to select the most appropriate disposal strategy for each problem area. Records of decision have been issued in other circumstances (e.g., the Colbert Landfill site in Colbert, Washington) that allow flexibility in the remedial design/remedial action phase.

8.5.2. According to EPA's figures, confined aquatic disposal is about 1/3 the cost of nearshore disposal and much more likely to be feasible, given the lack of nearshore disposal sites. Therefore, confined aquatic disposal is more cost-effective than nearshore disposal.

Response: The Record of Decision specifies four confinement options for remediation of contaminated sediments and thus allows flexibility in selecting the most appropriate option for each problem area. As the commenter notes, cost and availability of disposal sites will be key factors in this selection process.

8.5.3. The benefits of remedial action have not been clearly identified and demonstrated to exceed the costs.

Response: CERCLA does not mandate that individual remedial actions be selected based on the result of a cost-benefit analysis; a consensus on assignment of monetary values to environmental quality and human health is impossible to achieve. Cost is merely a balancing criterion for consideration of remedies that are otherwise equally protective of human health and the environment.

9. IMPLEMENTATION AND MONITORING

A number of comments were received on the process for implementing key elements of the selected remedy, particularly source and sediment monitoring. Comments on these topics were received from various PRPs, and federal and state agencies. Comments generally addressed the timing and suitability of the 10-year recovery period, the role of routine dredging, and the process for implementing monitoring programs and interpreting monitoring data.

9.1 Comments on Timing of Source Control, Sediment Remedial Action, and Natural Recovery

9.1.1. Stormwater drains and other nonpoint sources of pollution are not identified or will not be controlled until after other sources, and therefore sediment remediation will not be effective. The obligation for stormwater source control must be established by the Record of Decision.

Response: Stormwater drains have been identified, and a monitoring program administered by Ecology is to identify those to which source control shall be applied. Details of the source control element are described in the response to Comments 6.1.1 and 6.2.1. Sediment remediation in a problem area cannot proceed until adequate source control is achieved in that problem area.

9.1.2. The 10-year period for natural recovery appears to be arbitrary and unjustified.

Response: The remediation of all sediments in the CB/NT site with contaminant concentrations at or above the cleanup goals was considered inappropriate because remediation of all such sediments may result in more environmental disruption (through dredging and capping activities) than might be expected if some of the less contaminated sediments were allowed to recover naturally. In addition, the cost of remediating marginally contaminated areas could not be justified in all cases. To achieve a balance between protection of human health and the environment, and cost-effectiveness, the feasibility study employed a sediment recovery model (SEDCAM) to define areas of the CB/NT site that would be expected to recover within a 10-year period.

Many commenters suggested alternative natural recovery periods, ranging from 2 to 25 years. Some suggested that natural recovery should be allowed to proceed for 10 or more years even in the most highly contaminated areas before remedial action is undertaken. The 10-year recovery period was selected by Ecology and EPA to define areas requiring sediment remediation. The 10-year recovery period was selected based on assumptions about source control, the rate of accumulation of new sediment, and the degree of mixing of old and new sediment because of burrowing organisms and physical processes. Control of all priority sources in the CB/NT site is planned according to the implementation schedules in Appendix C. Maximum environmental and human health benefit will be derived in a cost-effective manner by remediating the most contaminated sediment sites first, because of the time required for full implementation of source control. The results of the SEDCAM modeling indicate that some sediments will recover naturally during a 10-year period, and therefore, do not warrant further disruption by sediment remedial action. Such actions would also be less cost-effective in the short-term. Sediment monitoring will be implemented to verify the results of SEDCAM modeling. The results of modeling will be periodically evaluated to determine the status of sediment recovery and the potential need for additional source control measures or sediment remediation.

9.2. Comments on Time Schedules

9.2.1. Timetables for remedial action do not give an adequate allowance for the completion of source control.

Response: Updated versions of the implementation schedules presented in the integrated action plan (PTI 1988) are provided in Appendix C. Schedules have been revised to reflect more recent information on the status of source identification and control activities. These schedules were developed for planning purposes, and depend on continuing resource availability, successful negotiations with PRPs, and timely implementation of source control.

9.2.2 Comments on the draft feasibility study are far reaching and cannot truly be adequately addressed and responded to in just a few months (i.e., by summer or early fall of 1989).

Response: The agencies have reviewed and considered all comments. All comments that were considered germane to the selection of remedy have been summarized and responded to in this Responsiveness Summary. Other comments that were not germane to the selection of the remedy but that may be important for remedial design, remedial action, or additional source control are summarized in Section IV and are listed in the annotated bibliography in Section V.

9.2.3 When the proposed 10-year clock for natural remediation starts is not clearly stated. It is essential that the sequence of all events be clearly established.

Response: The beginning of the 10-year time period for natural recovery will coincide with implementation of sediment remedial actions, which will begin after control of major sources as described in Comment 6.3.1. For problem areas where the entire area of sediment exceeding sediment quality objectives is predicted to recovery naturally in 10 years, the recovery period will begin after the baseline monitoring program (which may correspond to remedial design sampling). Adequate recovery in natural recovery areas is to be confirmed by biological and chemical testing as part of required monitoring. If the agencies determine from these monitoring data that adequate recovery has not occurred in the designated timeframe, then remediation may be required even if the area was originally predicted to recovery naturally.

9.2.4. Further testing and evaluation is mandated to identify and quantify "toxic hot spots" before implementing remedial action.

Response: Refinement of the areal extent and severity of contamination will be refined during remedial design sampling.

9.3. Comments on Routine Dredging Projects

9.3.1. Maintenance and development dredged material which passes PSDDA requirements should be allowed to go to the PSDDA disposal sites.

Response: This comment assumes separation of sediment into suitable and unsuitable categories for open-water disposal by applying PSDDA testing methods. It is recognized that clamshell dredges have a horizontal accuracy sufficient to maintain separation of sediments. Maintenance and development dredging waste is allowed at PSDDA sites if it meets PSDDA disposal guidelines for open-water unconfined disposal. CERCLA actions do not cover routine maintenance dredging activities.

9.3.2. Maintenance dredging may remove contaminated sediment, making remedial dredging unnecessary.

Response: Feasibility and cost analyses have been prepared presuming that all sediments in problem areas, even those in channels that may be subject to maintenance dredging, will be removed by remedial action dredging. As the extent and schedule of maintenance dredging is unknown, this is a conservative assumption, and allows planning for worst-case remedial actions. It is not likely that maintenance dredging will make remedial dredging unnecessary, because for the eight CB/NT problem areas described in this Record of Decision, any material that is not predicted to recover naturally and that does not pass PSDDA guidelines for open-water unconfined disposal, will be remediated as part of a Superfund action.

9.3.3. Additional volumes of contaminated material and disposal options have not been recognized for maintenance and development dredging that may occur in some areas designated for natural recovery.

Response: CERCLA actions do not cover maintenance dredging. Contaminated sediments encountered during remedial dredging must be disposed of in accordance with PSDDA or other applicable guidelines.

9.4. Comments on Source Monitoring

9.4.1. Washington Department of Transportation has performed remediation and monitoring of tar and copper bordering City Waterway and should not be listed as a PRP.

Response: Runoff from Interstate-5 is the primary source of contamination of concern relative to Washington Department of Transportation, not the contaminants uncovered and removed during construction of the Tacoma Spur.

9.4.2. The Washington Department of Transportation and the state of Washington should be listed as PRPs, based on an estimate that Interstate-5 contributes about 40 percent of the pollution entering Commencement Bay.

> **Response:** This comment is being considered by EPA in its PRP search.

9.4.3. The feasibility study does not acknowledge the efficiency of the management practices, including source control, remedial actions, and implementation of secondary treatment that have already been implemented at the ore handling facilities on Sitcum Waterway and Kraft mill on St. Paul Waterway.

> **Response:** The feasibility study focused on sediment remedial alternatives for the nine problem areas. The integrated action plan provided a general description of source control actions still needed at major sources, but it was not intended to provide a detailed history of source control actions at each facility. It is the responsibility of Ecology to track environmental management activities at each facility, to review past actions, to determine what additional source control measures are necessary, and to see that those additional measures are implemented.

9.4.4. Developing state policy indicates that a sediment impact zone may be designated for sources that are implementing AKART, but are unable to meet sediment criteria without unreasonable cost. The feasibility study should address: 1) How the decision to require (or not require a sediment impact zone will be made; 2) What technical bases are to be used to define the area of a sediment impact zone; 3) What effect will a sediment impact zone have on the long term timing of sediment remedial actions; 4) What monitoring of a sediment impact zone will be required; 5) What long term remedial actions will be required where a sediment impact zone is established; 6) What parties will be responsible for monitoring and, in essence, stand behind the sediment impact zone.

> **Response:** Guidelines for the development, operation, and closure of a sediment impact zone are being developed by Ecology. The sediment impact zone policy will be recognized in the evaluation of the acceptability of source controls that is conducted prior to implementing sediment remediation. If the continued discharge resulting in sediment contamination is clearly in the public interest, a wastewater discharge permit may define a specific sediment impact zone for the discharge, and require periodic maintenance until better methods of treatment can be identified and implemented. This permit] would not likely delay capping or dredging contaminated sediments because such cleanup actions provide a clean baseline for monitoring the discharge.

9.5. Comments on Sediment Monitoring

9.5.1. Location of a confined aquatic disposal site in Commencement Bay must take into account PSDDA siting considerations and monitoring.

> **Response:** The selection of in-waterway confined aquatic disposal as the preferred alternative will not conflict with the PSDDA disposal site or monitoring locations.

9.5.2. Monitoring of newly exposed sediment following dredging should not be done unless there is an expectation that the new surface will be toxic.

> **Response:** Monitoring of the newly exposed surface is intended to characterize the completeness of the cleanup and establish a basis for later determining whether natural recovery or recontamination is taking place, and if habitat restoration is successful.

9.5.3. Monitoring of the newly exposed sediment should be done, but by a surface grab sample taken immediately after dredging rather than by a core; this will be a considerable cost savings.

> **Response:** The newly exposed surface is expected to be subject to mixing with deeper sediments, both as a result of bioturbation and physical disturbance. A core taken after dredging will indicate whether there is subsurface contamination that may be brought to the surface, and will provide a basis for interpretation of long-term monitoring data.

9.5.4. Monitoring of sediments not clearly exhibiting benthic toxicity is recommended at five and 10 years following source control. Monitoring following cleanup must be required..

> **Response:** Monitoring requirements are discussed in Section 10 of the Decision Summary and in the integrated action plan (PTI 1988). Monitoring is required after source control and any sediment remedial action to demonstrate the effective remediation of problem areas and integrity of disposal sites.

9.5.5. Confined aquatic disposal sites are experimental and therefore require more compliance and environmental monitoring than stated in the feasibility study.

> **Response:** Confined aquatic disposal site monitoring is briefly outlined in the integrated action plan. Specific monitoring plans for each site will be developed during the remedial design phase.

IV. REMAINING ISSUES

Some issues and concerns were raised that were not germane to the selection of remedy but which do warrant consideration by the agencies. These issues are marked as "Deferred" and will be considered and factored into remedial design and action. These issues and concerns included:

1. Incorporation of new information developed post-record of decision as described in Section 10.3 of the Record of Decision and briefly discussed in the response to Comment 5.1.3
2. Success of future source control and the impact on remedial action plans; the success of source control will be monitored and adequate source control will be required before sediment remedial action begins
3. Future public input to the integrated action plan, which will be through participation in the Technical Discussion Group and public comment periods on individual consent decrees that implement specific cleanup plans
4. ASARCO's comments specific to sediments in the Ruston-Pt. Defiance problem area, which will be considered public comments for the new ASARCO sediments operable unit
5. Other detailed comments that are relevant to remedial design considerations (i.e., specific comments on the area, volume, and characteristics of contaminated sediments); these comments were not relevant to the selection of remedy but will be further considered at the start of remedial design.

V. ANNOTATED BIBLIOGRAPHY

Comments abstracted from materials submitted by citizens, and representatives of various agencies, PRPs, and citizen groups are summarized in this section. Additional detailed comments were submitted during the comment period as part of major documents, such as ENSR (1989), Kaiser Aluminum and Chemical Corporation (1989), Pennwalt Corporation (1989), Puyallup Tribe of Indians (1989), and ASARCO (1989). These comments were considered in developing responses to the major summary comments that were identified in these reports and listed in this section.

AOL Express, Inc. (1989)

See Response 3.3.1	*[W]e feel it is important that consideration be given to the level of cleanup, taking into account the multiple use nature of the area and the importance of a healthy local economy.*
See Response 6.1.1 and 8.2.1	*We feel that with effective source control monitoring and the availability of an adjacent disposal site, a reasonable and cost-effective remedy can be achieved.*
Deferred	*The public storm drains in our area drain into the "Blair" waterway, a site not designated for any cleanup action...we support [the position to have "responsible parties" do the cleanup], but strongly maintain that we are not a responsible party [in the Hylebos Waterway]. The best way to deal equitably with the smaller business who is demonstratively not involved in pollution of the waterway is to enter into immediate negotiations for release either by outright dismissal or deminimis settlement.*

ASARCO (1989)

See Response 1.1.3	*The Feasibility Study has failed to comply with the NCP in that it is too broad [comprising the entire bay] and is based upon inadequate data [for any given segment of the bay]. Based upon the [recent] findings of [the Tacoma Smelter site RI/FS], EPA should withdraw in its entirety that portion of the Commencement Bay FS dealing with the area offshore of the Tacoma smelter and should revise the FS based upon the data.*
See Response 3.3.1	*The Feasibility Study is based upon an improper remedial action goal . . . the sediment quality goal, "no acute or chronic adverse effects on biological resources or significant health risk to humans" . . . is unconnected with any requirement of CERCLA and is not mandated by any ARAR . . . [the goal] far exceeds CERCLA's goal of protecting the environment . . . and is not attainable [as a clean up objective. A goal of sediment quality that supports a properly functioning in situ benthic community and does not pose a significant risk to human health, is attainable and much more in keeping with the stated statutory objectives of CERCLA.*
See Response 6.1.1 and 6.3.1	*Appropriate source control should be undertaken and achieved before any offshore remedial action.*
See Response 7.2.3	*The impact of natural recovery processes have been greatly underestimated by Tetra Tech. Once onshore source control has been attained [at the Asarco Tacoma Smelter], it is highly likely that physical removal of contaminated*

	sediments by currents and wave action will be achieved. This activity was not properly considered by the FS.
See Response 1.1.5	*The FS has failed to take into consideration the fact that much of the contamination targeted for remedial action [at the Asarco Tacoma Smelter] is a result of a "federally permitted release" and therefore not actionable under CERCLA. . . At a minimum, the FS should consider the impact of federally permitted releases and exclude contamination from such releases from any remedial action recommended or set up the proper method for crediting the PRP for such releases.*
See Response 8.3.1	*The FS alternative for the area offshore of the Asarco Tacoma Smelter is contrary to the objectives of CERCLA [because it . . .] contains a healthy, and in some cases, very unique benthic community . . . extensive dredging is not only unnecessary, but would itself adversely impact the environment through total destruction of health benthic communities.*

[Numerous specific comments followed in the comment letter that pertained to the Asarco Tacoma Smelter site; attachments included a "Review of Commencement Bay Feasibility Study" by Parametrix, Inc. and Black & Veatch, "review of Commencement Bay Integrated Action Plan" by Parametrix, Inc., "Review of 13.0 Ruston-Pt. Defiance Shoreline Commencement Bay Feasibility Study" by Parametrix, Inc., and "Technical Review of the Apparent Effects Threshold Approach" by Tetra Tech, Inc., and the "Asarco Tacoma Smelter Remedial Investigation" by Parametrix, Inc. (1989).]

American Savings Bank (1989)

Deferred	*[O]bjects to its designation as a potentially responsible party . . . [and] reserves the right to comment further when [the Proposed Plan] is completed.*

Buffelen Woodworking Company (1989)

See Response 6.1.1 and 6.3.1	*We agree with EPA that the priority should be to work with the responsible parties to ensure that source control is complete before starting sediment remediation.*
See Response 8.2.3	*The EPA should consider alternatives to the Port of Tacoma Slip #1 on the Blair Waterway. Comments . . . indicate that the Port needs the use of this site before clean-up can reasonably expect to be completed.*
See Response 1.1.6	*We disagree with the method the EPA has for assessing costs against the PRP's as an aggregate group rather than on an individual basis. This method can result in the PRP with the most effective attorney being responsible for the smallest percentage of the cost. . .*

Champion International (1989)

See Response 8.2.7	*In view of the fact that [the clean-up of St. Paul Waterway as outlined in the Consent Decree] has been completed and has been judged to be successful, Champion urges EPA to accept the project as completed in the ROD for the Commencement Bay site. Champion agrees with the FS conclusion as set forth in [Section 8.6] that in situ capping of the problem area of St. Paul Waterway is the preferred alternative. The ROD should accept this recommendation.*

Information noted	*[The St. Paul] project was completed under Ecology supervision and with EPA being kept fully informed of the nature of the project and its progress . . . [the] Consent Decree . . . provides, among other things, for long-term maintenance and monitoring.*
Information noted	*The Tacoma kraft mill was acquired by Champion as a result of the merger of St. Regis Paper Company into Champion.*
Information noted	*The activities described in the subsection entitled "Sediment Remediation and Habitat Restoration" have been completed and approved by Ecology.*
Request noted	*The administrative record for this FS should include the Consent Decree [for the St. Paul Waterway area].*
Request noted	*Champion agrees with the comments of the Commencement Bay Group [and] urges EPA to seriously consider those comments in connection with the ROD.*
Citizen Letters (1989)	**(See Background on Community Involvement section)**
City of Tacoma (1989)	
See Response 3.3.1	*[T]hese efforts [to facilitate a cleanup plan] must be cost-effective and focused on achievable goals that accommodate the valuable commercial and industrial activity surrounding Commencement Bay.*
See Response 4.3.1 and 3.1.1	*The Apparent Effects Threshold (AET) does not provide an appropriate cleanup standard because it does not adequately differentiate between effects caused by individual chemical contaminants and effects caused by other factors. The proposed AET-based standard also targets some sediments for active remediation where there are thriving ecological communities.*
See Response 7.2.2	*We concur with the Feasibility Study that ongoing sources of contamination must be curtailed before any remedial dredging occurs, and support the concept of natural sediment recovery. However, we conclude that the criteria defining areas allowed to recover naturally are too restrictive . . .*
See Response 7.2.4	*An error was made in applying the sediment recovery model at the Head of City Waterway. A recalculation of the model using the correct data from the Feasibility Study indicated that most of the waterway will recover naturally if source controls are implemented. The dredge boundaries proposed in the Feasibility Study would result in needless costs and disruption of biological communities at both the dredge and disposal sites.*
See Response 8.2.1 through 8.2.3	*The Feasibility Study does not identify feasible and cost effective response actions for most waterways because it fails to identify available disposal sites for the quantities of materials proposed for dredging . . .*
See Response 8.4.1	*The Feasibility Study does not identify feasible and cost effective response actions for most waterways . . . because it greatly underestimates remediation costs. The cleanup plan proposed in the Feasibility STudy for $28 million could cost in excess of $100 million to implement.*
See Response 2.1.1	*Commencement Bay sediments do not pose a significant human health risk. The actual health risks from Commencement Bay sediments are similar to*

	The actual health risks from Commencement Bay sediments are similar to those reported for Carr Inlet and other non-urbanized Puget Sound waterways, and are within the range of risks that EPA has considered acceptable in other situations.
See Response 6.5.1	*The first element of the cleanup plan to proceed with is implementation of source controls. The City of Tacoma has already initiated a program to identify and remove existing sources of contamination from municipal storm drains, and we are also studying the feasibility of treating storm runoff entering the Head of City Waterway.*
See Response 4.4.2	*In recognition of the AET and sediment recovery model limitations, we suggest that only sediments with concentrations clearly exhibiting benthic toxicity be remediated immediately, in order to take full advantage of natural recovery.*
See Response 3.2.1 and 3.2.2	*Biological criteria used to define dredging boundaries must be based on analyses of the resident benthic communities. These analyses should be of sufficient detail to differentiate toxic effects from other site specific or environmental effects.*
See Response 9.5.4	*In areas not clearly exhibiting benthic toxicity, sediment concentrations and biological recovery [should] be monitored at 5 and 10 years following completion of source controls. Sediments not meeting the long-term cleanup goal after 10 years [should not] be remediated.*
Request noted	*We suggest that the U.S. Environmental Protection Agency and the Washington Department of Ecology open a local office for their joint use. We further suggest that the local site managers be assigned full-time at that office.*

City of Tacoma (1989); Attachment A—Review of 10.0 Head of City Waterway

See Response 5.3.1 and 5.1.2	*The Feasibility Study overestimates mass loadings for most sources . . . [and] has not adequately evaluated the nature and extent of [sources within drainage basins] based on our more extensive information.*
See Response 7.2.1 through 7.2.4	*The SEDCAM model, as used in the Feasibility Study, overestimated the time required for natural recovery of City Waterway sediments. This overestimate of the time required for natural recovery is the result of erroneous assumptions.*
See Response 8.4.1	*The estimated costs of sediment remediation are seriously underestimated by the Feasibility Study.*
See Response 6.2.1	*The Feasibility Study proposes infeasible end-of-pipe source control measures.*
Request noted	*The "Environmental Significance" rating for the head of City Waterway should be "low" rather than "medium."*

(Plus additional comments following summary comments.)

City of Tacoma (1989); Attachment C—Review of Commencement Bay Integrated Action Plan

See Response 1.2.4	*The Integrated Action Plan . . . suffers from the same reliance on AETs*

[as the Feasibility Study]; ignores dredging and disposal impacts; uses the SEDCAM model that underestimates the rate of natural recovery; does not consider the benefits to be derived from using a natural recovery goal greater than 10 years; proposes an inadequate biological testing program. These short comings . . . should be remedied before any actions are undertaken.

(Plus additional comments following summary comments.)

Commencement Bay Group (1989) [also cited as ENSR (1989)]

See Response 5.1.2 6.4.1 and 6.4.2	*The RI did not identify and quantify contaminant sources in sufficient detail to allow reliable estimates of current contaminant loadings and achieveable source control. Because of inadequate source characterization, the source loading and source control estimates made in the FS are based on technically unsupportable assumptions. These estimates of two of the most fundamental elements of site clean-up, are highly uncertain and are likely to be in error [detailed discussion in Chapter 4 of the ENSR report].*
See Response 2.1.1	*The FS over-estimated the human health risks in Commencement Bay by nearly an order of magnitude. This lower risk is within the generally acceptable range and is comparable to the risk reported in the FS for Carr Inlet the (the reference area) [sic]. This indicates that sediment clean-up based on human health risk is not warranted in Commencement Bay [detailed discussion in Chapter 3 of the ENSR report].*
See Response 3.3.1	*The sediment clean-up objective, "no acute or chronic adverse effects on biological resources", using Apparent Effects Thresholds (AETs) as the clean-up standard, is not attainable sustainable [sic] in Commencement Bay. This goal defines pristine conditions. Commencement Bay is an active port and industrial area which cna [sic] never achieve pristine conditions. Prop wash, maintenance dredging and other urban activities will prevent the pristine goal from being achieved. There is insufficient source characterization information to predict attainment and maintenance of the AETs without repeated dredging and disposal. An achievable and sustainable sediment clean-up objective and standard should be established before implementing sediment remediation [detailed discussion in Chapter 1 of the ENSR report]*
See Response 4.1.1	*AET's fail to establish cause and effect relationships between contaminants and biological responses.*
See Response 4.2.1	*The long term sediment clean-up standard (AETs) can be a useful indicator of potential adverse effects, but is not an appropriate clean-up standard or proper measure of clean-up effectiveness [because of the following three comments on AET]. . . These flaws severely restrict the use of AETs as a clean-up standard. [detailed discussion in Chapter 2 of the ENSR report]*
See Response 4.3.1	*[AET fail to] differentiate between adverse and non-adverse effects.*
See Response 4.3.2	*[AET fail to] quantify the extent of adverse affects [sic].*
See Response 7.2.3	*The sediment recovery model (SEDCAM) can be useful as an indicator of the relative rate of natural recovery but is not an appropriate tool for making major program decisions. Insufficient and unreliable model input data from Commencement Bay has resulted in recovery time predictions that may be several times longer than actual recovery times. Sediment recovery*

	is best estimated by monitoring actual recovery following source control [detailed discussion in Chapter 5 of the ENSR report]
See Response 8.2.1 through 8.2.8	*The FS failed to identify feasible and cost-effective response actions for most waterways. Most alternatives identified and evaluated in the FS including the preferred alternatives can not be implemented because of the lack of sufficient disposal capacity. [detailed discussion in Chapter 6 of the ENSR report]*
See Response 3.3.1 7.1.3 6.1.1 8.2.1 8.4.1 2.1.1 4.3.1 and 3.1.1	*Our basic concerns about the proposed cleanup plan include [are summarized as follows] . . . The cleanup goal for Commencement Bay should be realistically based on the present and future uses of the Bay. . . Natural remediation is an effective way to address this historical process, coupled with continuing efforts to "turn off the spigot" on ongoing pollution sources. . . Source controls should be implemented first, and their effectiveness measured, before any remedial dredging occurs. . . The Feasibility Study does not identify feasible and cost-effective response actions for most waterways because it fails to identify available disposal sites. . . and because it greatly underestimates remedial costs. . . Commencement Bay sediments do not pose a significant human health risk. . . AET . . . does not provide an appropriate cleanup standard . . . The AET approach also targets some sediments for active remediation where there may be thriving ecological communities. . .*
Deferred	*The no-effect station setting an AET may appear to satisfy the definition of AET simply because the sampling was truncated in the midst of a series of sporadic effect stations at a point where the highest concentration happened to be an adverse biological effect station. There should be some assessment as to whether the AET value is likely to be solely the result of sporadic effects rather than consistent adverse effects above the AET.*

(Plus additional comments in sections of the ENSR report.)

DNR (1989)

See Response 9.4.3	*[T]he FS [should] address: 1) How the decision to require (or not require a SIZ [sediment impact zone] will be made; 2) What technical bases are to be used to define the area of a SIZ; 3) What effect will a SIZ have on the long term timing of sediment remedial actions; 4) What monitoring of a SIZ will be required; 5) What long term remedial actions will be required where a SIZ is established; 6) What parties will be responsible for monitoring and, in essence, stand behind the SIZ*
See Response 9.5.5	*Any CAD [site] would be an experiment and require more compliance and environmental monitoring than what has been identified in the FS cost analysis.*
See Response 3.2.5	*At the current time the Department of Natural Resources acting for the State of Washington in terms of aquatic land ownership does not approve of CAD sites because of the issue of monitoring and technical feasibility. . [and] liability. . . The feasibility of the CAD site is questionable.*
See Response 4.1.1	*The Department agrees with the basis premise that the AET method is the best method available at the present time to identify sediments requiring remedial action.*

See Response 1.2.1	*The Department agrees that the long term goal as translated into the AET values stated . . . in the Feasibility Study is appropriate and that the actual decision can be refined through additional biological analysis. . .The utilization of performance criteria is very appropriate. . .*
See Response 8.4.2	*The volume of sediment proposed for dredging has not been adequately determined even in a general way*
See Response 8.2.1	*The volume capacity of the nearshore fill and the CAD sites is probably significantly less than proposed.*

(Plus additional specific comments.)

DOT (1989)

Deferred	*Based on [information attached], WSDOT [requests to] be removed from [the CB/NT site] PRP list. . . [and requests a written response as to] why WSDOT was not sent even a general notice letter until April 24, 1989, well into the comment period on the RI/FS and at least five years into the RI/FS process.*

Dunlap Towing Company (1989)

See Response 5.2.4	*First it must be recognized that Commencement Bay is an urban estuary with a large drainage basin. Not only are there industrial pollutants entering the Bay, but contaminants from automobiles, farms and storm drains also run off into its waters.*
Deferred	*Some of [the fish in Commencement Bay] display abnormalities, the sources of which have not been identified for certain, however, they are the type of tumors and lesions that are generally found in fish from waters that have been contaminated with residues from non-point pollution sources such as automobile exhaust and pesticides as well as chemical manufacturing sources.*
See Response 3.3.1	*The goal of "no adverse affects" is inappropriate and would have a severe negative impact on one of the nations most active ports.*
See Response 8.4.1	*The costs of the remedial alternatives in the Feasibility Study are grossly understated and have been projected to be as much as three times these estimates.*
See Response 8.5.3	*The Feasibility Study does not adequately justify the costs of dredging compared to the minimal measurable environmental benefit it will provide.*
See Response 5.2.1 and 6.1.1	*The priority for cleanup of Commencement Bay should be the control of the sources of pollution (both point and non-point). . . Dredging should not be considered until source control and a monitored period of natural recovery have been completed.*

Foss Maritime Company (1989)

See Response 8.5.1	*Foss supports attempts to develop a cost-effective cleanup plan that is reasonable and appropriate under the circumstances present in Commencement Bay.*

See Response 3.3.1	*[W]e question whether the long-term cleanup goal of no adverse effects on marine life is appropriate for an urban bay, a working port, and a developing economy.*
See Response 5.2.1 and 9.1.1	*Control of airborne emissions and surface runoff from highways, storm drains, farms, construction activities, an other [non-point] sources simply may not be sufficient to support a goal of "no adverse effects."*
See Response 5.1.2	*We believe [the FS] focus on ship building and repair activities as the source of copper and mercury in Middle Waterway is speculative. . .Other possible sources, such as nearby industries and storm drains in the Waterway, have not been considered thoroughly. . .[and] sampling conducted to date is not sufficient to provide a clear picture of contaminant distribution in the Waterway.*
See Response 4.1.1	*[I]t does not follow that observed concentrations of [copper and mercury] should be the basis for cleanup decisions. The AET approach to sediment quality does not establish causality between a particular contaminant and a biological impact. . . Numerous studies, including ongoing work at the Asarco smelter in Tacoma, indicate that the metals in slag may not be generally bioavailable.*
See Response 8.4.2	*The volume of contaminated sediments quoted in the FS (57,000 cubic yards) is likely underestimated [in Middle Waterway]. This volume assumes a 1.5 foot cut . . . more likely, however, a 2 to 3 foot cut would be used . . .*
See Response 8.2.3	*Disposal of the [Middle Waterway] sediments in Slip 1 near the mouth of the Blair Waterway may not be feasible [because of an unsuited filing] schedule. . . . [difficulties in defining and apportioning] responsibilities for monitoring . . .the capacity of Slip 1 may be overstated in the FS . . [and] alternative sites for nearshore sills may be available close to Middle Waterway.*
See Response 8.4.1	*Costs presented in Appendix D of the FS appear low by a factor of two or more. Specifically, the estimated costs listed for dike construction ($0.51/cubic yard) should be more in the range of $8 to $12/cubic yard of dike, while the estimated costs for monitoring wells ($2,000/well) should be closer to $5,000/well. Despite the overall underestimate of cleanup costs, however, the relative cost ranking of cleanup alternatives is likely valid.*
Deferred	*Clamshell dredging and nearshore disposal appears to be a desirable alternative . . . [and] [a]ssuming cleanup of the Waterway is warranted, this recommendation appears appropriate for the reasons stated in the FS.*

General Metals (1989)

See Response 1.1.3	*EPA's proposed remedy for the head of the Hylebos problem area is not appropriate or consistent with the National Contingency Plan.*
See Response 4.1.1	*Remedial action consistent with CERCLA's "Protection of Human Health and the Environment" standards does not require dredging to meet AET levels. . . Dredging is not needed to meet ARARs. The AET level for PCBs is not needed to assure protection of human health. EPA is without the authority to compel the PRPs to dredge as part of remedial action in these circumstances.*

See Response 8.2.10	*We request that . . . EPA change its preferred alternative for the head of the Hylebos Waterway to source control with natural recovery or, in the alternative, if EPA re-analyzes its alternatives, to remove PCBs as an indicator chemical.*
See Response 5.1.1	*EPA's characterization of sources of PCBs is inadequate to support remedial action or to identify sources.*
See Response 8.5.1 8.4.1 and 1.1.1	*EPA has not shown that the Agency's preferred alternative for the head of Hylebos Waterway is cost effective. . . First, the cost analysis is extremely inaccurate. Second, the plan is not reliable. Third, the plan does not adequately provide long term or permanent solutions to the contamination problems at the site.*

Griffin Galbraith Fuel (1989)

See Response 6.1.1	*Stopping all source and non source pollution should be our first priority.*
See Response 9.1.2	*After the sources of pollution are stopped we should give nature sufficient time to remediate the pollution. . . [T]wenty to twenty five years should be given for natural remediation.*
See Response 7.1.3	*Save dredging for those truly "Hot Spots," after source control, to disturb and spread the contaminated sediments as little as possible.*
See Response 8.5.3 8.2.1 and 8.4.1	*A current cost-benefit analysis should be performed based on disposal sites and contracting costs available today. . . the sites used in the Tetra Tech study may not be practical solutions or will not be available.*
See Response 3.3.1	*One ex-director of the EPA stated that in some cases the agency clean up demands are for a more pristine state than occur in nature. We cannot overlook the fact that Commencement Bay is an industrial and population center. We need cleanup goals that are achievable with not eliminating people and their livelihood from the area.*
Deferred	*Since it is estimated that I-5 contributes about 40% of the Commencement Bay pollution, the Department of Transportation and the State of Washington should be listed as Potentially Responsible Parties.*

Jones Chemicals, Inc. (1989)

See Response 3.3.1	*This site is a large working port, and has been an industrial area for 100 years. It is not realistic to believe that it can or should be restored to pristine conditions.*
See Response 1.3.1 and 1.1.2	*The goal of "no acute or chronic adverse effects" on marine organisms is not required by any applicable law and should not be adopted as the goal for cleanup. . . the plan as proposed could require continuous cleanup efforts to try to reach an unattainable goal.*
See Response 8.4.1 and 8.5.3	*. . . EPA's estimate [for costs at Superfund sites] is always below the actual cost, often by 100% or more. In addition, this cost does not include any of the costs of source control, which area a key part of the Integrated Action Plan. EPA is therefore contemplating a societal cost (regardless of who actually pays) of tens of millions of dollars. More consideration*

should be given to whether the benefits to the environment and indirectly to human health justify that level of investment of society's resources.

See Response 8.2.1	*Perhaps the most important [specific problems with the plan] is the lack of any suitable disposal site for dredged material which is proposed for "nearshore disposal."*
See Response 9.1.2	*EPA should reconsider allowing more time for natural recovery, coupled with institutional controls, to work before any dredging occurs.*
See Response 8.5.2	*If dredging is necessary, the material should be disposed of using confined aquatic disposal for all areas within the site. According to EPA's figures, aquatic disposal is about 1/3 the cost of nearshore disposal and is much more likely to be feasible, given the lack of nearshore disposal sites.*
See above Responses	*In short, we support the following cleanup plan for the Nearshore/Tideflats site: aggressive source control to eliminate continuing sources of contamination, followed by a period of natural recovery. There is no reason why this period should be limited to 10 years if monitoring shows it is making satisfactory progress. Dredging should be a last resort if natural recovery is not making headway.*

Kaiser Aluminum and Chemical Corporation (1989)

See Response 6.1.1 9.1.1 6.3.1 and 9.2.1	*Effective control of all significant sources must occur before [undertaking] remedial action. . . the FS [has not] adequately identified potential sources, characterized sources [including non-industrial sources], or determined source loadings of contaminants to Commencement Bay. . . [and] timetables for remedial action do not give adequate allowance for the completion of source control. . .*
See Response 3.2.1 and 4.4.2	*[T]he goal for the cleanup [should] be defined based on what is necessary to protect human health and the environment from significant adverse impacts . . . cleanup should only be required in areas where an ecologically significant (not statistically significant) benefit can be shown.*
See Response 7.1.2	*[N]atural recovery [should] be the preferred cleanup alternative except in cases where it plainly will not protect human health and the environment in the long term. . . It does not disrupt the existing ecosystem or resuspend sediments. . . [and] is appropriate for an urban bay which has received contaminants for many years from many historic sources.*
See Response 8.3.1	*The negative impacts of dredging are not adequately considered in the Feasibility Study and supporting documents. . . [dredging] should not be used . . . where the impacts exceed the environmental benefits of remediation.*
See Response 9.1.2	*In the FS, the selection of ten years as an appropriate natural recovery period appears to be arbitrary. . . [the reasons cited do not] explain why a longer period is not preferable. . . the long-term goal of "no impact" was intended by the [Puget Sound] Plan to be much longer than a ten year period.*
See Response 8.4.1	*[T]he costs of the preferred remedial alternatives are greatly underestimated in the FS. In addition, the costs of source control . . . and monitoring costs were not included. . .*

See Response 8.2.1	*[T]he FS does not identify feasible disposal sites for dredged material.*
See Response 8.5.1	*It will be difficult for businesses located at the CBNT site to adequately budget and plan for the future if critical aspects of the cleanup plan may be changed mid-course.*
See Response 4.2.1 and 1.2.2	*AETs may be useful as predictive tools for the PSDDA program . . . [but not for] determining that a particular sediment should be remediated. . . Nevertheless, the FS still cites PSDDA as a justification for using AETs for cleanups. Given the different goals, the citation is inappropriate.*
See Response 8.4.2	*The FS admits that its area and volume estimates are based on multiple assumptions and are not likely to be accurate. . . FS decisions on remedial action alternatives are not appropriately based on such weak information.*
See Response 8.5.2 and 8.2.9	*The FS does not adequately justify nearshore disposal over confined aquatic disposal ("CAD") for the HHW [Head of Hylebos Waterway].*
See Response 9.2.2	*The comments of Kaiser and the CBG alone are far reaching (as necessitated by the complexity and size of the Site) and cannot truly be adequately addressed and responded to in just a few months [i.e., by summer or early fall of 1989].*
See Response 8.5.1	*. . . the agencies must not [in a performance based ROD] place the burden of meeting a certain cleanup standard on the PRPs unless at least one alternative is identified that both meets the standard and meets CERCLA's requirements regarding effectiveness, implementability, and cost.*
See Response 1.1.6	*Considering [urban runoff, historic sources, and NPDES-permitted discharges exempt from CERCLA coverage], the Superfund should be tapped to pay for a least a portion of the remediation costs at Commencement Bay.*
Comment noted	*Kaiser agrees that there are no feasible or cost effective treatment alternatives available for the large quantities of dilute contaminants present in Commencement Bay sediments.*
See Response 1.1.3	*A single Superfund action is not an appropriate way to address such a large and varied area. If anything, dozens of smaller sites should have been listed instead of one huge site.*
See Background Section	*In general, the study of the CBNT Site process was compromised by not soliciting input from industry -- the parties who should know the most about what is feasible at the Site. The agencies should now embark on a program to correct the misconceptions regarding Commencement Bay.*

Louisiana-Pacific Corporation (1989)

See Response 7.2.3	*The SEDCAM model needs to account for arsenic losses from sediments. . . Site-specific studies of arsenic fluxes from areas proposed for cleanup should be conducted . . . [and] used in evaluating whether natural sediment recovery is feasible for areas currently proposed for cleanup.*

See Response 5.1.2 and 6.1.1	*The FS does not accurately characterize arsenic sources and loadings into the head of the Hylebos. . . Sources contributing to Hylebos Creek must be curtailed before any cleanup of sediments . . . since Hylebos Creek is the largest contributor of arsenic in this immediate area.*
Deferred	*The priority rankings in the Integrated Action Plan do not reflect actual contributions of arsenic. . . Parties should not be given lower priority on the grounds that they are recalcitrant.*
See Response 6.4.1 and 6.4.2	*The evaluation of source control technologies in the FS does not provide sufficient consideration of factors encountered at log sort yards and wood waste landfills to hold that the technologies are feasible at log sort yards.*

Manke Lumber Company (1989)

See Response 9.2.1 5.2.1 and 5.1.2	*The implementation schedule suggested by the Feasibility Study (FS) creates a substantial likelihood of recontamination of remediated sediments [because] . . . many of the potential sources of contamination have not been identified . . . a number of [identified sources of contamination] have not yet been controlled . . . there is inadequate data with respect to many, if not most, point and non-point sources of contamination.*
See Response 7.1.2	*The natural recovery of the sediments should be the preferred remedial alternative, and should be abandoned only if absolutely necessary.*
See Response 8.3.1 and 1.1.7	*A dredge and fill operation would further destroy present biological communities . . . [and] would create secondary contamination problems at the site of disposal, contrary to the present Super Fund Policy to remediate contaminants on site.*
See Response 7.2.3	*The sedimentation rate estimated in the FS is based upon assumptions with out adequate data, and may well be understated.*
See Response 3.3.1	*. . . the goal of . . . "no adverse effects" . . . is not obtainable in an urban environment. . . Commencement Bay and its waterways cannot be returned to the pristine state they were in before man came to the Commencement Bay area.*
See Response 4.4.2	*A more realistic goal in an urban environment is no significant effect on biological resources.*
See Response 2.1.4	*The process by which health risks are estimated . . . is grossly exaggerated [sic]. The FS contains assumptions as to consumption of fish and fish livers which have no basis in fact.*
See Response 4.1.1	*[T]he AETs are faulty in as much as they do not establish a cause and effect relationship between contaminants and biological responses*
See Response 4.3.1	*[T]he AETs are faulty in as much as . . . they do not distinguish between adverse and nonadverse effects.*
See Response 4.3.2	*[T]he AETs are faulty in as much as . . . they do not quantify the extent of adverse effects.*
See Response 8.2.1	*The availability of disposal sites should be confirmed before the FS process is completed so that factor of cost effectiveness can adequately be addressed in the remedial action selection process.*

See Response 1.2.1	*The cleanup goal has been created in a vacuum and is premature. The Department of Ecology is obligated in the future to develope [sic] Puget Sound-wide sediment standards for regulating discharges and for determining when sediment remedial actions are necessary. Those regulatory actions should occur prior to the finalization of the FS. and certainly before the issuance of any Record of Decision.*

Martinac Shipbuilding (1989)

See Response 2.1.1	*While there does exist a problem to some degree, the implied threat to public health and the health of the marine environment has been grossly overstated.*
See Response 3.3.1	*What is an appropriate and achievable level of cleanliness for an urban, industrial waterfront area? There is a balance that must be struck between the adverse effects to the marine environment and the adverse effects to the people who work at the businesses and live in the community.*
See Response 9.1.2	*[W]e should seriously consider extending the time horizon allowed for natural recovery to occur. We are dealing with a 100 year old problem and in relative terms proposing to solve it overnight.*

National Oceanic and Atmospheric Administration (1989)

See Response 1.3.4	*The long-term goal of "no acute or chronic effects on biological resources" would be protective of NOAA trustee resources. [Because] cost and technical feasibility are factors that would be considered in the overall evaluation of actions . . . [the goal] may not be achieved in all areas under the Superfund cleanup.*
See Response 3.3.2	*The use of lowest AET values is probably the most appropriate general approach to setting target levels in Commencement Bay, even though the approach has not been fully developed. . . It is clear that AETs do represent concentrations that are associated with biological impacts. Thus it can be concluded that the AETs are clearly based on documented effects, but may easily underestimate the full range of injury that may be caused by toxic substances [e.g., chronic effects].*
See Response 4.3.2	*The possibility exists that combinations of two or more substances may result in greater toxicity than indicated by the individual AET values. In the case of Commencement Bay, however, the AETs are based on local data so that the last concern should not be a problem. In addition, the test procedures upon which the AET are based are probably the most reliable and may be among the most sensitive available. . . Finally, the AET approach provides a means of evaluating the need for remediation of sediments from deeper cores that may not be completely testable [using biological indicators].*
See Response 9.1.2	*The proposed 10-year "natural recover" period proposed in the FS presents some substantial problems . . . [because] Superfund legislation has only been authorized in increments of five years or less, with the strong implication that cleanup should be completed at many sites within that time frame . . . No justification is presented, nor is any analysis given, for the statement that a 10-year period presents an "optimal balance" between cleanup-associated disruption and the problems associated with the toxic*

	substances [which by allowing] to continue will also continue to injure natural resources and threaten human health.
See Response 7.2.1 and 7.2.3	*[T]he change in concentrations in the surface sediments in most areas will be on the order of a factor of two after 10 years of "recovery." This level of change is on the order of the precision with which the concentrations of substances in the sediments can be reliably measured, and within the accuracy of the [SEDCAM] model. AS a result, the potential for error in meeting the cleanup goals if the recovery period calculation is allowed is large.*
See Response 9.2.3	*[I]t may be difficult to determine after 10 years that recovery has actually taken place. If not, will the PRP be allowed another 10 years to demonstrate that the process is working? [This] could lead to substantial failures to meet the cleanup goals.*
See Response 9.1.2	*While the PSWQA does include the recommendation that natural recovery be considered in cleanup action, it does not specify that 10 years should be used and the consideration does not necessarily apply to Superfund sites. In addition, the contamination at this site was identified and has been studies, with limited real action, for 10 years already.*
See Response 7.1.1	*Since [the natural recovery] process is limited to only the upper layer of contaminated sediments (upper 10 cm), any contamination in the deeper sediments will be unaffected. This process is therefore defacto in situ capping. In situ capping was rejected for all waterways except the St. Paul because of the high likelihood that the sediments in all of the other waterway would be dredged for maintenance or new construction.*
See Response 7.1.3	*The proposed "natural recovery" is simply a slow form of dilution. The same result could be achieved without the delay and uncertainty that would occur by allowing in situ capping. The recovery period sets a precedent of allowing dilution as part of a Superfund cleanup action. This approach has been clearly rejected at all other sites.*
See Response 1.1.1	*The FS is clear in recognizing that none of the confinement options meet the SARA preference for a permanent solution, as defined by reductions in the toxicity, mobility, or volume of the contamination.*
See Response 8.4.1	*[M]onitoring and maintaninance [sic] [of nearshore disposal sites] will have to perpetuated [sic] for centuries to come. It is questionable whether the costs of this long-term O&M have been fairly incorporated into the feasibility study, since it appears that only a 30-year period was used and for some sites, monitoring is costed for the first 10 years.*
Deferred	*In general, the [sampling and monitoring] guidelines are reasonably well thought out, but could be more specific with regard to the numbers of stations that may be needed.*
Deferred	*The bioassay recommendations are reasonable, but may well need to be revisited in the not-too-distant future as new bioassays are developed.*
Deferred	*The statement in the appendix [p. A-10 of the Integrated Action Plan] that the exceedance of a single chemical cleanup goal [in a marginally contaminated area] may be negotiable does not seem to be supported in the main body of the text. Since six of the nine problem areas have only two or [one] problem substances, this provision would seriously weaken the*

	potential cleanup and may lengthen the negotiation period. It should not be accepted.
See Response 9.2.3	***[W]hen the proposed 10-year clock for natural remediation starts is not clearly stated. . . It is essential that the sequence of all events be clearly established.***

Occidental Chemical Corporation (1989)

Deferred	***The [RI/FS] reports do not consistently and clearly distinguish that [Occidental Chemical Corporation] is not the identified source of the high priority contaminant PCBs in the mouth of the Hylebos Waterway. . . [a]s a result [of the detailed Remedial Investigation at the OCC Tacoma Plant site] OCC concludes they are not the source for PCBs to the Mouth of the Hylebos.***

Pennwalt Corporation (1989)

See Response 1.1.2	***[The] "no effects" standard is not realistic or achievable as a cleanup standard for an urban waterway like Commencement Bay. Nor is it legally required as a cleanup standard under section 121(d) of SARA, 42 U.S.C. ss 9621(d), the current or proposed National Contingency Plan (NCP), or EPA guidance documents.***
See Response 4.4.2	*[An] alternative cleanup goal [is proposed]: mitigate significant effects to the aquatic ecology. . . Under this objective, only those sediments with significant benthic depressions and which offer significant and measurable ecological benefits would be identified as suitable candidates for active remediation.*
See Response 8.2.10	*The FS does not identify a feasible or cost-effective remedial alternative for the head of Hylebos Waterway. A modified institutional controls alternative should be the preferred alternative for the head of Hylebos Waterway . . . [requiring] removal only of the sediments that would exceed cleanup standards after source controls, natural remediation, and maintenance dredging.*
See Response 8.5.2	*Confined aquatic disposal may be preferable to nearshore disposal for any sediments that require dredging.*
Comment noted	*The FS correctly rejected treatment alternatives*
See Response 8.5.1	*A performance based record of decision is only appropriate if the performance standard is based on a feasible and cost-effective alternative. . . It is impossible to determine whether the cleanup standards and performance criteria are feasible and cost-effective, as CERCLA requires, unless they are tied to a particular remedy.*

(Plus additional comments in an attached report by Kennedy/Jenks/Chilton (1989) following these summary comments.)

Pickering Industries Inc. (1989)

See Response 5.1.3 and 7.1.3	*We do not agree that [City] waterway needs to be dredged. . . We believe EPA should first control the sources of contamination, and then should leave the City waterway alone for an extended period of time, for example, 10 years or more, to see whether the pollution has abated naturally. . . [i]f it has not, a decision can then be made about dredging.*
See Response 3.3.1	*We are very concerned that the standards the feasibility study uses are too high for the [City] waterway.*
See Response 2.1.1	*[Apparently] the feasibility study attempts to clean the City waterway so that English sole do not develop cancerous tumors. . . a person would have to eat absurdly large quantities of fish liver for their entire lives in order to contract cancer from such fish. . . this is totally unrealistic and presents and inappropriate standard by which to determine whether dredging is necessary.*

Port of Tacoma (1989)

See Response 5.1.2	*A particular concern is the inadequacy of the data base for historic and current sources.*
See Response 6.4.1	*[T]he FS overestimates the feasibility and effectiveness of source control measures.*
See Response 6.4.2	*The FS establishes a goal of 60-95% control of all sources. It is not clear whether the 60-95% requirement will be additional to source control measures implemented since RI sampling in 1985 . . . [or] how the goal will be verified due to the lack of baseline data.*
See Response 8.4.1	*The considerable costs of source control, monitoring, and future implementation are not included in the FS. . . The cost estimate of $28 million significantly underestimates the cost of implementing the preferred remedial action [which is estimated to be] three to four times greater than stated in the FS.*
See Response 3.3.1	*[T]he FS' proposed cleanup goal for this Superfund site, unlike cleanup levels in other urban marine sites, requires the equivalent of pristine conditions. . . [the] proposed cleanup standards . . . are not attainable nor sustainable within Commencement Bay's urban setting.*
See Response 5.2.1	*The FS performance standard does not acknowledge the impact of recontamination from continuing sources [including urban runoff].*
See Response 9.4.3	*The relationship between [Ecology's] implementation of sediment impact zones and cleanup standards needs to be addressed.*
See Response 7.2.3	*Use of the SEDCAM model (which has not been field tested) to predict future sediment conditions may have led to incorrect conclusions concerning the proposed remedial actions.*

See Response 4.1.1 and 4.2.1	*. . . the AET method is appropriate only as a screening tool to identify areas warranting more thorough environmental investigation . . . [because] AETs cannot demonstrate specific cause and effect relationships. AETs also cannot predict that an environmental effect will be caused by levels of chemicals that exceed the AET level.*
See Response 4.3.2 and 4.3.1	*The AET artificially ascribes all changes in benthic communities as being equally adverse, and assumes all changes are due to the presence of chemical contaminants.*
See Response 4.2.2	*Use of AET is particularly questionable in intertidal areas.*
See Response 4.4.2 and 4.3.1	*Given the probable need to proceed with some cleanup, and in the absence of consensus on sediment quality measurements, the Port supports application of the AET approach defined in the CBG/ENSR report, provided that proper consideration of physical factors is given during cleanup decisions.*
See Response 2.1.1	*The FS overestimates the relative human health risks of sediment contamination in Commencement Bay. . . by using unrealistic assumptions.*
See Response 9.3.3	*Plans for remedial dredging should recognize plans for navigation dredging. When navigation needs are considered, the total volume of sediments requiring confined disposal will be much larger than that predicted solely for remedial dredging.*
See Response 8.2.9	*Feasible and cost-effective strategies for removing contamination under [pier] structures are not identified nor discussed [although] capping or removal of surface sediments involves a high risk of pier structure or slope failure . . . methods are infeasible . . . untried and costs range from $1.7 to $5.5 million.*
See Response 8.2.1	*The FS does not identify cost-effective and feasible disposal sites for the large quantities of sediments designated for cleanup.*
See Response 8.2.3	*The present timetable for cleanup will result in [proposed disposal site in Blair Waterway] Slip 1 not being available. . . other Port owned disposal sites are also not available.*
Deferred	*[T]he agencies [should] consider further the following three [disposal] sites: 1) the Wheeler Osgood Waterway; 2) the Saint Paul Waterway; and 3) the Hylebos Disposal Site #1 (combined use with fisheries enhancement).*
See Response 1.2.4	*In particular, the Port is concerned about the regulatory status of the Integrated Action Plan. . . What is the process for public comment on the IAP?*
See Response 6.1.1	*A systematic look at all sources, their contribution, degree of achievable control, and priorities for control should be defined. The framework for such a plan should be established prior to the ROD. . .*
See Response 5.2.2	*Resolution of source control and drainage planning issues related to the uplands must occur prior to issuance of a ROD for submerged portions of the site. . . Without a RI/FS and a ROD for source control, PRPs cannot obtain CERCLA resolution of Superfund liability.*

(Expansion of comments followed in attachments "Analysis of Proposed Surface Water Source Control Requirements for the Commencement Bay Nearshore/Tideflats Superfund Area" by R.R.

Horner; Hart Crowser review letter; "Contaminated Sediments on Side Slopes of Sitcum Waterway" by Berger/ABAM Engineers; "Review of Various Aspects of Commencement Bay Nearshore/Tideflats Feasibility Study" by Berger/ABAM Engineers; and "Assessment of Risks Associated with Eating Recreationally Harvested Puget Sound Seafood" by L. Williams and C. Krueger; and public testimony at 6 June 1989 meeting by J. Terpstra.)

Premier Industries Inc. (1989)

See Response 6.1.1 and 7.1.2	*[S]ource control [including non-industrial sources] and natural remediation appear to be the most economical and effective means for cleaning up Commencement Bay.*
See Response 9.2.4	*Further testing and evaluation is mandated to identify and quantify "Toxic Hot Spots" . . .*
Deferred	***As an alternative to removing approximately 11,000 cubic yards of contaminated soil and finding a disposal site [for Wheeler-Osgood sediment], why not construct a sea wall and fill in the waterway with approximately 75,000 cubic yards of dredged material from the City Waterway and cap with clean soil.***

PSWQA (1989)

See Response 1.3.1	***The long-term sediment cleanup goal selected for Commencement Bay is also the sediment goal of the Puget Sound Water Quality Management Plan . . . The Authority supports adoption of this goal.***
See Response 1.2.1	***The Authority supports the use of the apparent effects threshold method (AET) to estimate chemical concentrations associated with harm to marine life. The use of bioassays to refine areas and volumes for remediation is also supported.***
See Response 7.1.2	*The Authority . . . supports the use of natural recovery, after source control has been achieved, for portions of the sites that will recover within ten years. The dilution and burial of moderately contaminated sediments by clean sediment is an acceptable way to accomplish the cleanup goal.*
See Response 7.2.3	*Authority staff have questioned . . . [whether] the rates of recovery predicted by the [SEDCAM] model are too slow and underestimate the rate of natural recovery.*
See Response 6.1.1	*The application of all known, available, and reasonable methods of treatment to all point sources and rigorous application of best management practices to nonpoint sources is required.*
Suggestion noted	*Improved spill prevention programs throughout the drainage basin and improved spill response capabilities should be addressed [in the [illegible]AP].*
See Response 9.4.3	***If the continued discharge [that still results in sediment contamination] is clearly in the public interest, a wastewater discharge permit should define a specific sediment dilution zone (also called a sediment impact zone) for the discharge, and require periodic maintenance. . .until better methods of treatment can be identified and implemented. [This permit] should not delay capping or dredging contaminated sediments . . . such cleanup actions provide a clean baseline for monitoring the discharge.***

See Response 8.3.2	*The Authority supports the use of a range of remediation techniques. depending on site conditions. . . [but] The policy of no net loss of wetland habitat, as adopted by EPA, the State of Washington, and the Puget Sound Plan, must be met.*
See Response 9.5.4	*Monitoring [of cleanup and disposal sites] must be required.*
See Response 3.3.1	*The Authority supports cleanup of Commencement BAy because of the public benefits that will result. . . [from mitigation of harm to] natural marine life . . . [and reduction of] human health risk associated with eating seafood.*

Puget Sound Plywood, Inc. (1989)

See Response 3.3.1	*Our first concern is that the Feasibility Study's cleanup goals are unrealistic because they fail to adequately account for the present and future uses of Commencement Bay.*
See Response 6.6.1	*[T]he Feasibility Study does not place sufficient emphasis upon stopping ongoing pollution at its source and allowing natural recovery processes to remediate much of the existing sediment pollution problem.*
See Response 6.6.1 and 7.1.2	*[S]ource control should be fully implemented and tested before sediment remedial dredging occurs.*
See Response 8.2.1	*[T]he Feasibility Study fails to identify feasible and cost-effective response actions because, among other matters, it does not clearly and convincingly identify disposal sites for contaminated sediments.*

Puyallup Tribe of Indians (1989)

See Response 1.1.4	*[T]he Tribe has not been provided with a meaningful opportunity to participate in [the FS] proceeding.*
See Response 1.1.3	*The FS should take into consideration EPA's proposed NCP which implements SARA.*
See Response 1.1.1	*The goals of the FS must be permanent cleanup.*
Request noted	*The Tribe formally requests documentation demonstrating that [EPA's and Ecology's contractors] have no conflict of interest with any Potentially Responsible Party [at the CB/NT site].*
See Response 1.3.5	*Tribal standards must be considered as ARARs*
See Response 1.3.7	*The Puyallup Land Claims Settlement Agreement . . . must be considered as an ARAR.*
See Response 1.3.2	*EPA's proposed Maximum Contamination Level Goals must be adopted as a groundwater ARAR [not as a TBC]. . . The American Indian Religious Freedom Act, the National Historic Preservation Act and Tribal standards must be considered for all locations impacting Tribal resources.*
See Response 3.3.1	*. . . Commencement Bay [must] be fully remediated, and protected as an exercise of . . . public trust.*

See Response 7.1.1	*[T]he identification of contaminated sediments [may be] greatly underestimated. . . capping dangerous sediments in place . . . will not provide adequate human and environmental protection.*
See Response 7.2.3	*The use of the SEDCAM model is likely to underestimate recovery rates.*
See Response 8.4.1	*The use of a 10 percent discount rate over a 30 year period does not accurately reflect the long term costs of monitoring and maintaining a site through institutional controls.*
See Response 1.3.4	*[A]ll of [the nine criteria used to evaluate the alternatives] are not entitled to equal weight. Protection of human health and the environment must be the most important criteria.*
See Response 1.1.1 and 1.3.5	*The Puyallup Tribe finds the recommended remedial action alternative totally unacceptable . . . [because it] will not prevent bioaccumulation . . meet tribal standards. . . [and] is not a permanent solution.*
See Response 2.1.4 and 2.1.6	*The FS must address cumulative health impacts to Tribal families that rely on fish for a large portion of their diets, and to fishermen that spend a lot of time fishing within Commencement Bay . . . [including] effects of dioxins, heavy metals, and thousands of other chemicals [besides PCB mixtures] . . . Cumulative health risks from all dangerous chemicals must be addressed.*
See Response 6.1.1	*A source control strategy must develop specific plans for [immediate] control of permitted, unpermitted point source, and nonpoint source discharges. . . before significant sediment remediation is undertaken.*

(Plus numerous additional specific comments and attached Superfund Memorandum of Agreement, Puyallup Tribal Water Quality Program, Letter documenting Tribal ARAR, resolution requesting inclusion of Tribal Environmental Standards, and U.S. EPA Drinking Water Regulations and Health Advisories.)

Sierra Club (1989)

See Response 3.3.1 and 6.1.1	*While we recognize that industry has been located in this area for a good many years, we must not zone the bay into clean and dirty areas, but rather assure multiple uses of the bay. . . Appropriate technologies must be utilized to prevent continued contamination of these waters and adjoining sediments.*
See Response 1.1.2	*The Sierra Club supports the long-term cleanup goal [of no adverse effects]. . . Of the several potential approaches for establishing sediment quality values, the AET approach seems the best in measuring acute harm. . . SPecific cleanup plans must go beyond the current AET assessment to include a complete assessment of chronic (sublethal) impacts and should address these impacts in the Record of Decision.*
See Response 3.3.2	*If further refinement does not allow complete assessment of AETs for chronic effects, we recommend that some chemical concentration ten to one hundred times below the lowest AET should be selected as the threshold for cleanup and monitoring, to provide a margin of safety and to allow for the unmeasured chronic effects mentioned above.*

See Response 1.1.1	*[A]ll cleanup efforts should meet the requirements of SARA and must be permanent. . . Because [permanence is not assured until specific disposal sites can be evaluated] we cannot support the preferred alternative.*
See Response 9.1.2	*If recovery cannot be demonstrated at [natural recovery sites] in the next five years, this approach should be reevaluated.*
See Response 6.1.1 and 9.5.4	*[A] strong source control program [is supported] . . . sediments . . . should be monitored for potential re-contamination.*

Simpson Tacoma Kraft Company (1989)

Comment noted	*Simpson agrees with the preferred alternative and generally agrees with the conclusions in the FS.*
Information noted	*[There is incorrect] [a]ttribution of historical problems to Simpson, which acquired the mill . . in 1985 [rather than to the Tacoma Kraft Mill and raw materials].*
Information noted	*[O]utdated information [is used in some cases] regarding source control and remedial action at the site [in the St. Paul Waterway area].*
Information noted	*[S]ome inaccurate and inconsistent conclusions [are made] on the summary charts [for the waterway].*
See Response 8.2.7	*[The FS incorrectly] suggest[s] that a new technology might be implemented rather than the preferred remedy evaluated and identified in the FS.*

Superior Oil Company (1989)

See Response 7.1.3	*Superior Oil agrees that [the "wait and evaluate" approach for the mouth of City Waterway] is reasonable, cost effective and protective of human health and the environment.*
See Response 3.3.1	*The [long-term] cleanup standard of "no adverse effects" does not recognize . . . [the fact that] City Waterway is unquestionably located in the heart of an industrial area. . . it is probably an unattainable standard.*
Information noted	*[T]here is nothing in the RI or FS that establishes a link between Superior Oil property and the contamination found in the City Waterway [despite one contradictory section in the FS that should be corrected].*

Tacoma-Pierce County Chamber of Commerce (1989)

See Response 6.1.1 and 6.3.1	*Ecology's and EPA's first objective should be to control existing sources of pollution to Commencement Bay before requiring that industry, the City, the Port and landowners invest an estimated $28 million on sediment remedial action.*
See Response 8.5.3	*No remedial action should be allowed, using private or public funds, until the benefits of action are presented for public review and the benefits clearly exceed the costs.*

See Response 1.1.6	*If . . .sediment remedial action should proceed after the public comment period closes, then the only reasonable approach would be to provide for a substantial CERCLA-funded percentage of the cost of remedial action.*
See Response 3.3.1	*The government should not aim to return the Bay to "natural" conditions . . . EPA's announced goal of "no adverse impact" is too stringent and fails to appreciate the reality of our urban setting.*
See Response 8.4.1	*EPA's figure of $28 million to cleanup the Bay is an underestimate [because of higher costs for alternative disposal sites, and sampling and analysis].*

Tacoma-Pierce County Health Department (1989)

See Response 6.1.1 and 6.3.1	*[A] greater emphasis needs to be placed on source control in the "integrated Action Plan" and a fully funded, pro-active, resource intense, source control program be developed and implemented. . . We would only be supportive of sediment removal or capping following a re-evaluation of the success of the above-described source control program.*

Tacoma-Pierce County Superfund Citizens Advisory Committee (1989)

See Response: Future Community Relations Plans section	*It is unclear how the agencies plan to promote public involvement in the cleanup process, but it is critical that the general public have access to specific and accurate information and are able to help shape decisions. . We hope documents are made available to members of the general public at little or no cost, and that it is easy for the public to obtain them.*
See Response 1.1.1 and 6.1.1	*The CAC supports the long-term cleanup goal . . .The CAC also feels that all cleanup efforts should be permanent, and that long term monitoring is essential. In addition, the CAC supports implementation of a strong source control program.*
See Response 1.2.3	*[T]he Department of Ecology and the EPA should continue to monitor activities in [areas other than the nine high priority problem areas], and should require site characterization and remediation prior to development.*

U.S. Army COE (1989)

See Response 1.2.2	*Some references [to the PSDDA study documents] are not totally correct and events subsequent to the preparation of the text have resulted in changes to the PSDDA management plan, portions of which are referenced in the FS text*
Deferred	*Proposed modifications of the PSDDA procedures [for analysis of dredging cut samples] in high priority areas . . . do not appear to be technically defensible and could result in unnecessary costs.*
See Response 3.2.4	*In the interest of consistency among the various sediment programs, consideration should be given to adopting the current PSDDA test protocols and guidelines for establishing what constitutes a bioassay 'hit'.*
See Response 8.2.5 and 9.5.1	*Siting of a deepwater CAD facility . . . should be undertaken . . . with consideration given to the PSDDA disposal siting process and the wide range of siting factors which must be taken into account.*

USG Interiors, Inc. (1989)

See Response 3.3.1	*Achieving [a "no adverse impact"] cleanup standard is neither appropriate nor achievable in Commencement Bay. . . The environmental concerns of Ecology and USEPA must be balanced with economic considerations.*
See Response 8.5.1	*With respect to the use of a performance-based Record of Decision . . . CERCLA requires that a remedy be chosen prior to the beginning of remedial activities. Ecology and USEPA, therefore, may not implement or require the implementation of remedial measures not specifically embodied in its ROD.*
See Response 6.1.1 and 6.3.1	*All [point and nonpoint] source discharges must be controlled prior to the implementation of containment measures.*
Deferred	*Source control coupled with natural recovery assisted by high tides and the removal of up to two-thirds of contaminated sediment through maintenance dredging may be sufficient to eliminate contaminated sediment and obviate the need for further remedial dredging.*
See Response 8.2.10	*[T]he dredging and disposal options proposed for the Head of Hylebos Waterway problem area both threaten to increase rather than reduce the negative impacts of existing contaminated sediment and are technically infeasible. . . Watertight clamshell dredges as well as other Japanese dredging technologies (mechanical, hydraulic, pneumatic) should be investigated to reduce the potential resuspension of sediment.*
See Response 8.2.1	*[N]o practical [nearshore] disposal site has yet been identified.*
See Response 8.4.1	*Given the scope and complexity of the proposed cleanup, [the $28 million] costs appear to be grossly understated.*

Washington Public Ports Association (1989)

See Response 9.3.1	*It is very important that [maintenance] dredged material . . . which passes the Puget Sound Dredged Disposal Analysis (PSDDA) requirements be allowed to go to the PSDDA disposal sites.*
See Response 3.3.1	*WPPA questions the goal of "no adverse effects due to sediment contamination" as a cleanup goal*
See Response 6.2.1	*The study should contain a more detailed cost evaluation for individual source control measures.*
See Response 7.2.3	*[I]t may be desirable to further test the predictive ability of the SEDCAM model before committing to remedial actions in ten years . . .*
See Response 4.1.1	*[T]he ports support [the use of AET] as a screening tools (as was done in the PSDDA study). However, we are concerned with the use of AET's as a cleanup standard. . .AET's cannot be used to predict cause and effect*
See Response 4.3.2	*. . . AET do [not] clearly indicate the ecological relevance of levels of contamination that exceed AET levels.*
See Response 8.2.1	*[W]e are very concerned about the lack of disposal sites for the volume of sediments that may be dredged . . . establishing a superfund disposal site within an urban area will be a very difficult task . . .*

VI. REFERENCES

GENERAL REFERENCES

Barrick, R., S. Becker, L. Brown, H. Beller, and R. Pastorok. 1988. Sediment quality values refinement: 1988 update and evaluation of Puget Sound AET. Final report. Prepared for the U.S. Environmental Protection Agency, Puget Sound Estuary Program, Office of Puget Sound, Seattle, WA. PTI Environmental Services, Bellevue, WA.

Becker, D.S., G.R. Bilyard, and T.C. Ginn. 1987. Concordance between laboratory sediment bioassays and the characteristics of benthic macroinvertebrate communities in Commencement Bay, Washington. Unpublished manuscript prepared for presentation at the Seventh International Ocean Disposal Symposium in Wolfville, Nova Scotia. PTI Environmental Services, Bellevue, WA. 28 pp.

Becker, D.S., R.A. Pastorok, R.C. Barrick, P.N. Booth, and L.A. Jacobs. 1989. Contaminated sediments criteria report. Final Report. Prepared for the Washington Department of Ecology, Sediment Management Unit, Olympia, WA. PTI Environmental Services, Bellevue, WA.

Chapman, P.M., R.N. Dexter, R.M. Kocan, and E.R. Long. 1985. An overview of biological effects testing in Puget Sound, Washington: methods, results, and implications. pp. 344-362. In: Aquatic Toxicology, Proceedings of the Seventh Annual Symposium. Spec. Tech. Report 854, American Society for Testing and Materials, Philadelphia, PA.

Chapman, P.M., R.N. Dexter, and E.R. Long. 1987. Synoptic measures of sediment contamination, toxicity and infaunal community composition (the sediment quality triad) in San Francisco Bay. Mar. Ecol. Prog. Ser. 37:75-96.

DeWitt, T.H., G.R. Ditsworth, and R.C. Swartz. 1988. Effects of natural sediment features on survival of the phoxocephalid amphipod, *Rhepoxynius abronius*. Mar. Environ. Res. 25:99-124.

ENSR. 1989. Technical review and comments for the record. Commencement Bay Nearshore/Tideflats Remedial Investigation and Feasibility Study. Prepared for the Commencement Bay Group (ASARCO Inc., City of Tacoma, General Metals of Tacoma, Kaiser Aluminum, Murray-Pacific Corporation, Pennwalt Corporation, Port of Tacoma). ENSR Consulting and Engineering, Redmond, WA.

Gahler, A.R., J.M. Cummins, J.N. Blazevich, R.H. Rieck, R.L. Arp, C.E. Gangmark, S.V.M. Pope, and S. Filip. 1982. Chemical contaminants in edible, non-salmonid fish and crabs from Commencement Bay, Washington. EPA-910/9-82-093. U.S. Environmental Protection Agency Region 10, Seattle, WA. 118 pp.

Gray, J.S. 1981. The ecology of marine sediments. Cambridge University Press, Cambridge, U.K. 185 pp.

Landolt, M.L., F.R. Hafer, A. Nevissi, G. van Belle, K. Van Ness, and C. Rockwell. 1985. Potential toxicant exposure among consumers of recreationally caught fish from urban embayments of Puget Sound. NOAA Technical Memorandum NOS OMA 23. National Oceanic and Atmospheric Administration, Rockville, MD. 104 pp.

Parametrix. 1989. ASARCO Tacoma Smelter remedial investigation. Volume 1. Prepared for ASARCO, Inc. Parametrix, Inc., Bellevue, WA.

Pastorok, R.A. 1988. Guidance manual for assessing human health risks from chemically contaminated fish and shellfish. Final report. Prepared for U.S. Environmental Protection Agency, Office of Marine and Estuarine Protection, Washington, DC. PTI Environmental Services, Bellevue, WA.

Pearson, T.H., and R. Rosenberg. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanogr. Mar. Biol. 16:299-311.

Pierce, D.S. D.T. Noviello, and S.H. Rogers. 1981. Commencement Bay seafood consumption study. Preliminary reports. Tacoma-Pierce County Health Department, Tacoma, WA. 11 pp.

PSWQA. 1988. 1989 Puget Sound water quality management plan. Puget Sound Water Quality Authority, Seattle, WA.

PTI and Tetra Tech. 1988a. Elliott Bay action program: analysis of toxic problem areas. Final report. Prepared for the U.S. Environmental Protection Agency Region 10, Office of Puget Sound. PTI Environmental Services, Bellevue, WA.

PTI and Tetra Tech. 1988b. Everett Harbor action program: analysis of toxic problem areas. Final report. Prepared for the U.S. Environmental Protection Agency Region 10, Office of Puget Sound. Tetra Tech, Inc., Bellevue, WA.

PTI. 1988. Commencement Bay nearshore/tideflats integrated action plan. Public Review Draft. Prepared for Tetra Tech, Inc., and the Washington Department of Ecology. PTI Environmental Services, Bellevue, WA.

PTI. 1989. Commencement Bay Nearshore/Tideflats Feasibility Study: Development of Sediment Cleanup Goals. Final Report. Prepared for the Washington Department of Ecology and U.S. Environmental Protection Agency. PTI Environmental Services, Bellevue, WA.

Rygg, B. 1985. Effect of sediment copper on benthic fauna. Mar. Ecol. Prog. Ser. 25:83-89.

Rygg, B. 1986. Heavy-metal pollution and log-normal distribution of individuals among species in benthic communities. Mar. Pollut. Bull. 17:31-36.

Tetra Tech. 1985. Commencement Bay nearshore/tideflats remedial investigation. Final report. EPA-910/9-85-134b. Prepared for the Washington Department of Ecology and U.S. Environmental Protection Agency Region 10, Office of Puget Sound. Tetra Tech, Inc., Bellevue, WA.

Tetra Tech. 1986. Development of sediment quality values for Puget Sound. Prepared for Resource Planning Associates/Puget Sound Dredged Disposal Analysis and Puget Sound Estuary Program, Seattle, WA. Tetra Tech, Inc., Bellevue, WA. 129 pp. + appendices.

Tetra Tech. 1988. Guidance manual for assessing human health risks from chemically contaminated fish and shellfish. Final Report. Prepared for U.S. Environmental Protection Agency, Office of Water, Washington, DC. PTI Environmental Services, Bellevue, WA.

U.S. EPA. Technical support document for water quality-based toxics control. EPA 440/4-85-032. U.S. Environmental Protection Agency, Office of Water, Washington, DC. 75 pp. + appendices.

U.S. EPA. 1988. Briefing report on the Apparent Effects Threshold approach. Submitted to the EPA Science Advisory Board by U.S. Environmental Protection Agency Region 10, Office of Puget Sound. PTI Environmental Services, Bellevue, WA. 57 pp.

Versar. 1985. Assessment of human health risk from ingesting fish and crab from Commencement Bay. EPA 910/9-85-129. Prepared for the Washington Department of Ecology under contract to the U.S. Environmental Protection Agency, Washington, DC. Versar, Inc., Springfield, VA.

Williams, L.G., P.M. Chapman, and T.C. Ginn. 1986. A comparative evaluation of sediment toxicity using bacterial luminescence, oyster embryo, and amphipod sediment bioassays. Mar. Environ. Res. 19:225-249.

COMMENTS RECEIVED DURING PUBLIC COMMENT PERIOD

AOL Express, Inc. 1989. AOL Express' comments on Commencement Bay nearshore/tideflats feasibility study.

ASARCO. 1989. ASARCO's comments on Commencement Bay nearshore/tideflats feasibility study.

ASARCO. 1989. ASARCO Tacoma smelter remedial investigation.

American Savings Bank. 1989. American Savings Bank's comments on Commencement Bay nearshore/tideflats feasibility study.

Buffelen Woodworking Company. 1989. Buffelen Woodworking Company's comments on Commencement Bay nearshore/tideflats feasibility study.

Champion International. 1989. Champion International Corporation's comments on Commencement Bay nearshore/tideflats feasibility study.

Citizen Letters. 1989. Comments from the general public on Commencement Bay nearshore/tideflats feasibility study.

City of Tacoma. 1989. City of Tacoma's comments on Commencement Bay nearshore/tideflats feasibility study.

Commencement Bay Group. 1989. Commencement Bay Group's comments on Commencement Bay nearshore/tideflats feasibility study.

DNR. 1989. Washington Department of Natural Resources' comments on Commencement Bay nearshore/tideflats feasibility study.

DOT. 1989. Washington Department of Transportation's comments on Commencement Bay nearshore/tideflats feasibility study.

Dunlap Towing Company. 1989. Dunlap Towing Company's comments on Commencement Bay nearshore/tideflats feasibility study.

Foss Maritime Company. 1989. Foss Maritime Company's comments on Commencement Bay nearshore/tideflats feasibility study.

General Metals. 1989. General Metals' comments on Commencement Bay nearshore/tideflats feasibility study.

Griffin Galbraith Fuel. 1989. Griffin Galbraith Fuel's comments on Commencement Bay nearshore/tideflats feasibility study.

Jones Chemicals, Inc. 1989. Jones Chemicals, Inc.'s comments on Commencement Bay nearshore/tideflats feasibility study.

Kaiser Aluminum and Chemical Corporation. 1989. Kaiser Aluminum and Chemical Corporation's comments on Commencement Bay nearshore/tideflats feasibility study.

Louisiana-Pacific Corporation. 1989. Louisiana-Pacific Corporation's comments on Commencement Bay nearshore/tideflats feasibility study.

Manke Lumber Company. 1989. Manke Lumber Company's comments on Commencement Bay nearshore/tideflats feasibility study.

Martinac Shipbuilding. 1989. Martinac Shipbuilding Corporation's comments on Commencement Bay nearshore/tideflats feasibility study.

NOAA. 1989. National Oceanic and Atmospheric Administration/Ocean Assessments Division's comments on Commencement Bay nearshore/tideflats feasibility study.

Occidental Chemical Corporation. 1989. Occidental Chemical Corporation's comments on Commencement Bay nearshore/tideflats feasibility study.

Pennwalt Corporation. 1989. Pennwalt Corporation's comments on Commencement Bay nearshore/tideflats feasibility study.

Pickering Industries Inc. 1989. Pickering Industries' comments on Commencement Bay nearshore/tideflats feasibility study.

Port of Tacoma. 1989. Port of Tacoma's comments on Commencement Bay nearshore/tideflats feasibility study.

Premier Industries Inc. 1989. Premier Industries, Inc.'s comments on Commencement Bay nearshore/tideflats feasibility study.

PSWQA. 1989. Puget Sound Water Quality Authority's comments on Commencement Bay nearshore/tideflats feasibility study.

Puget Sound Plywood, Inc. 1989. Puget Sound Plywood, Inc.'s comments on Commencement Bay nearshore/tideflats feasibility study.

Puyallup Tribe of Indians. 1989. Puyallup Tribe of Indians' comments on Commencement Bay nearshore/tideflats feasibility study.

Sierra Club. 1989. Sierra Club's comments on Commencement Bay nearshore/tideflats feasibility study.

Simpson Tacoma Kraft Company. 1989. Simpson Tacoma Kraft Company's comments on Commencement Bay nearshore/tideflats feasibility study.

Superior Oil Company. 1989. Superior Oil Company's comments on Commencement Bay nearshore/tideflats feasibility study.

Tacoma-Pierce County Chamber of Commerce. 1989. Tacoma-Pierce County Chamber of Commerce's comments on Commencement Bay nearshore/tideflats feasibility study.

Tacoma-Pierce County Superfund Citizens Advisory Committee. 1989. Tacoma-Pierce County Superfund Citizens Advisory Committee's comments on Commencement Bay nearshore/tideflats feasibility study.

TPCHD. 1989. Tacoma-Pierce County Health Department's comments on Commencement Bay nearshore/tideflats feasibility study.

U.S. Army Corps of Engineers. 1989. U.S. Army Corps of Engineers, Seattle District's comments on Commencement Bay nearshore/tideflats feasibility study.

USG Interiors, Inc. 1989. USG Interiors, Inc.'s comments on Commencement Bay nearshore/tideflats feasibility study.

Washington Public Ports Association. 1989. Washington Public Ports Association's comments on Commencement Bay nearshore/tideflats feasibility study.

ATTACHMENT TO APPENDIX B

Community Relations Activities

Community relations activities have been conducted by Ecology and EPA with assistance from TPCHD. This list refers specifically to Nearshore/Tideflats and *Areawide* activities. It does not include activities specific to ASARCO, Tar Pits, and South Tacoma Channel sites. Community relations activities include the following:

- Prepared the initial community relations plan (1983)
- Established and provided staff support for Citizens Advisory Committee [started in September 1983 with regular meetings ongoing through spring (1989)]
- Established and maintained information repositories (1983-present)
- Developed and maintained mailing list of interested individuals (1983-present)
- Periodically briefed Tacoma-Pierce County Board of Health and city/county government officials
- Provided information for working sessions with Pierce County Medical Society (1983)
- Gave presentations to elementary and high school students, to workshops for teachers (winter 1986), and to schools and community groups (1983-1986)
- Held press conference and gave tours of Commencement Bay (June 1984)
- Gave tours of Commencement Bay to the Citizens Advisory Committee (1984, August 1988) and student groups (June 1986)
- Distributed periodic Commencement Bay Superfund updates to the community (September 1986, April 1987, August 1987, March 1988, May 1988, April 1989, September 1989)
- Gave 27 community interviews for revised community relations plan (September 1987)
- Published notice and analysis of proposed plan in Tacoma News Tribune (24 February 1989)
- Distributed proposed plan fact sheet to over 2,500 individuals (24 February 1989)
- Presented public workshops, meetings, and hearings:

NOAA report, TPCHD fish advisory	April 1981
Cleanup plans	June 1983
Progress report	March 1984
Remedial investigation study plan	November 1984
Commencement Bay dredging disposal	September 1985
Remedial investigation results	June 1985
Remedial investigation results and comments	July 1985
Status report	November 1985
Tideflats businesses (business liability)	April 1989
Proposed plan	21 March 1989
Proposed plan and public comments	6 June 1989

- Provided briefing for public officials and members of the press (February 1989).

APPENDIX C

Implementation Schedules for Source Control and Sediment Remedial Action

CONTENTS

Page

LIST OF FIGURES C-iii

IMPLEMENTATION SCHEDULES FOR SOURCE CONTROL AND SEDIMENT REMEDIAL ACTION C-1

- HEAD OF HYLEBOS WATERWAY C-1
- MOUTH OF HYLEBOS WATERWAY C-6
- SITCUM WATERWAY C-6
- ST. PAUL WATERWAY C-10
- MIDDLE WATERWAY C-10
- HEAD OF CITY WATERWAY C-15
- WHEELER-OSGOOD WATERWAY C-18
- MOUTH OF CITY WATERWAY C-18

REFERENCES C-22

LIST OF FIGURES

Page

Figure C-1. Recent, ongoing, and planned activities at the Head of Hylebos Waterway C-2
Figure C-2. Hylebos Waterway - Existing industries and businesses C-3
Figure C-3. Recent, ongoing, and planned activities at the Mouth of Hylebos Waterway C-7
Figure C-4. Sitcum Waterway - Existing industries, businesses, and discharges C-8
Figure C-5. Recent, ongoing, and planned activities in Sitcum Waterway C-9
Figure C-6. St. Paul Waterway - Existing industries, businesses, and discharges C-11
Figure C-7. Recent, ongoing, and planned activities in St. Paul Waterway C-12
Figure C-8. Middle Waterway - Existing industries, businesses, and discharges C-13
Figure C-9. Recent, ongoing, and planned activities in Middle Waterway C-14
Figure C-10. City Waterway - Existing industries, businesses, and discharges C-16
Figure C-11. Recent, ongoing, and planned activities at the Head of City Waterway C-17
Figure C-12. Recent, ongoing, and planned activities in Wheeler-Osgood Waterway C-19
Figure C-13. Recent, ongoing, and planned activities at the Mouth of City Waterway C-20

IMPLEMENTATION SCHEDULES FOR SOURCE CONTROL AND SEDIMENT REMEDIAL ACTION

In this appendix, recent, ongoing, and planned activities are summarized for the major problem areas of the Commencement Bay Nearshore/Tideflats (CB/NT) Superfund site. Timelines depict major actions pertaining to the characterization and remediation of sources and adjacent sediments from 1987 to 1995. Details of source-related actions are provided in the supporting text.

The information contained in this section, particularly regarding the nature and timing of future actions, is tentative and was developed for planning purposes. The timing of source control actions is highly dependent upon the availability of agency staff and financial resources, the success of negotiations with potentially responsible parties (PRPs), and source control and investigation results.

Identification of additional sources will be supported by Urban Bay Action Team (UBAT) activities. The 1989 Puget Sound Water Quality Authority plan (PSWQA 1988) requires that action teams carry out various source control and investigative actions, including searches for unpermitted discharges, investigations of storm drain and groundwater contamination, and regulatory enforcement. The timing of sediment remedial actions is dependent upon the priority ranking of the problem area, the successful implementation of source control actions, negotiations with PRPs, the successful completion of the remedial design phase, and necessary coordination of remedial action with activities conducted in other problem areas. Because of these complicating factors, the timing of sediment remedial activities is subject to the greatest uncertainties. The schedules for source control and remedial activities reflect the status of those activities as of July 1989.

Remedial activities associated with storm drains in each of the problem areas will be regulated by the new National Pollutant Discharge Elimination System (NPDES) permit regulations to be adopted early in 1990. NPDES permit applications for industrial storm drains will be due 1 year later. NPDES permit applications for municipal storm drains will be due 4 February 1992. In addition, the 1989 PSWQA plan (PSWQA 1988) requires that local governments begin developing stormwater programs by 31 December 1989 and demonstrate significant progress on the programs by 31 December 1991. By the year 2000 the stormwater programs must be implemented.

HEAD OF HYLEBOS WATERWAY

Remedial activities at the Head of Hylebos Waterway are summarized in Figure C-1. Numerous sources have been associated with sediment contamination at the head of the waterway, including Pennwalt Chemical Corporation; Kaiser Aluminum and Chemical Corporation; General Metals, Inc.; several log sorting yards; and the landfills in the Hylebos Creek drainage basin. The locations of existing industries in Hylebos Waterway are shown in Figure C-2.

In the last several years, Kaiser Aluminum has implemented several remedial actions. These actions include re-routing of in-plant wastewater streams, installation of a settling basin between an NPDES-permitted discharge and Kaiser Ditch, and installation of a tide gate in Kaiser Ditch. Remaining scrubber sludges on the western portion of the site are addressed in the Sludge Management Closure Plan, submitted to the Washington Department of Ecology (Ecology) in September 1987, which proposed in-place capping as the preferred remedial action. Ecology has required additional groundwater monitoring and soil testing, as well as a risk assessment to determine whether the remaining scrubber brushes will need to be removed or if they can be disposed of onsite. A consent decree is in the draft/negotiation stage and should be completed in January 1990. It is anticipated that site stabilization activities will be performed during the summer of 1990 and require less than 6 months to complete. The effluent from Kaiser Aluminum is monitored under an NPDES permit, which is due for renewal in November 1989.

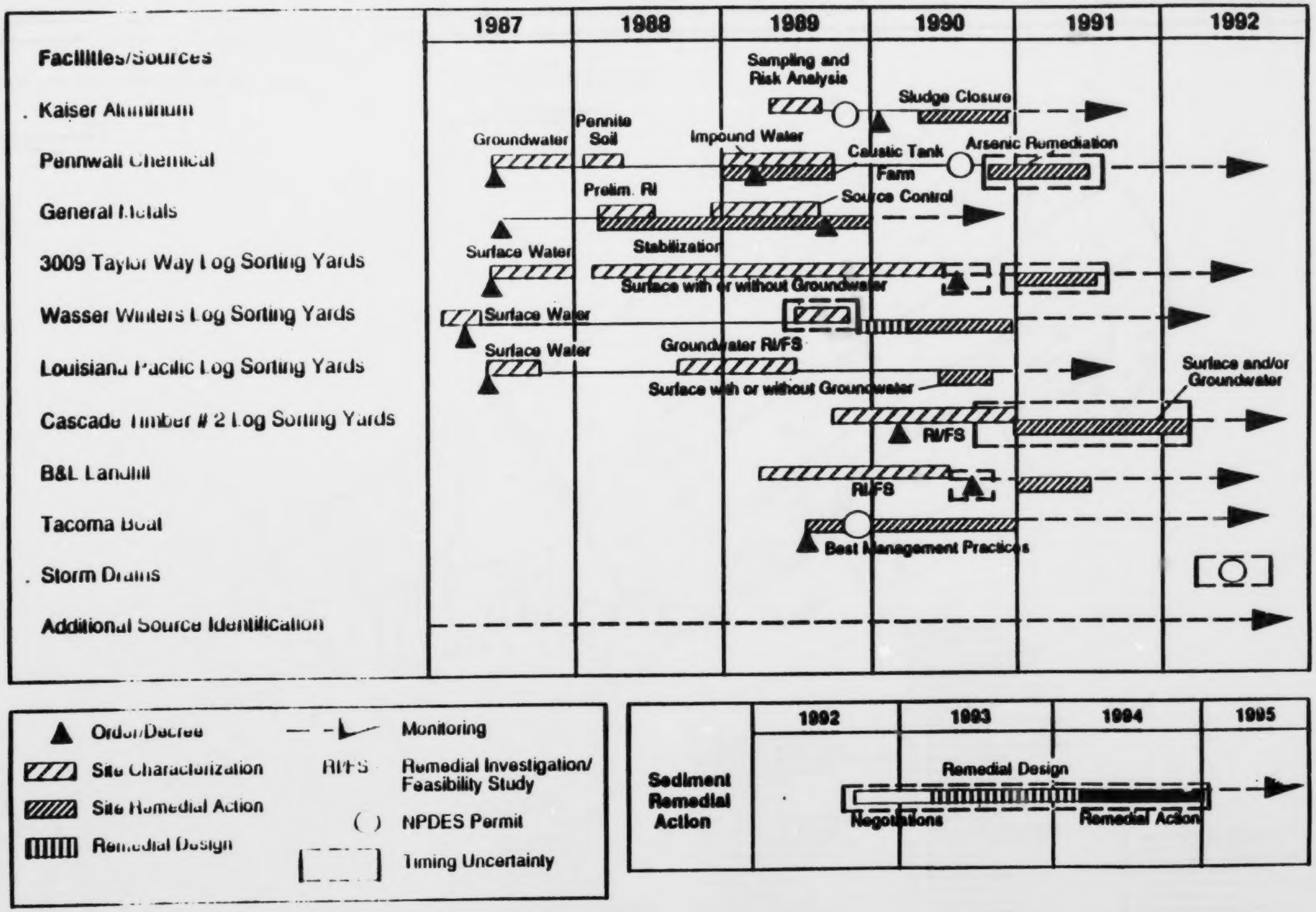
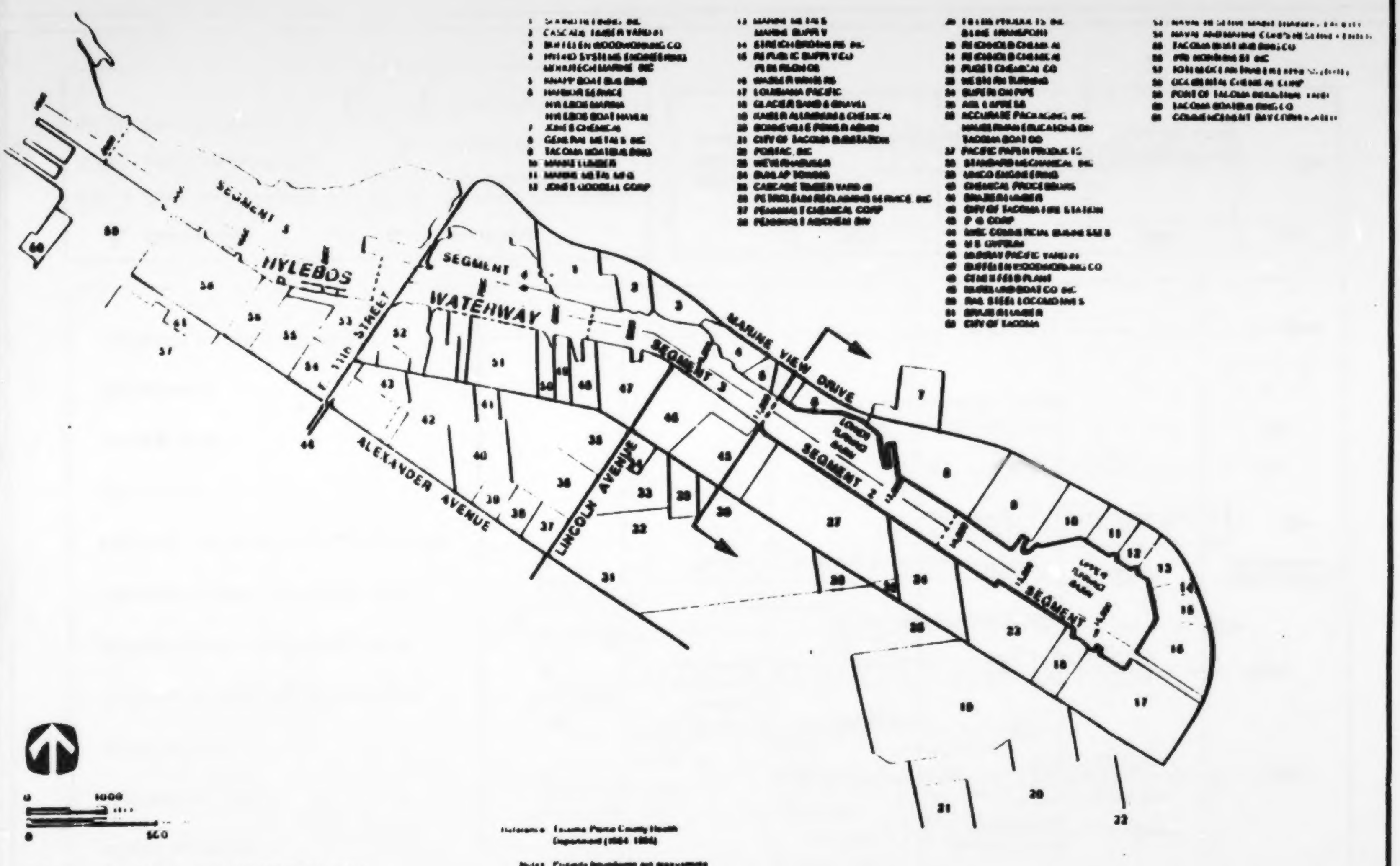


Figure C-1. Recent, ongoing, and planned activities at the Head of Hylebos Waterway


HYLEBOS
WATERWAY
SEGMENT 1
SEGMENT 2
SEGMENT 3
SEGMENT 4
SEGMENT 5
MARINE VIEW DRIVE
LINCOLN AVENUE
ALEXANDER AVENUE
11th STREET
LOWER TURNING BASIN
UPPER TURNING BASIN
1 [illegible] INC.
2 CASCADE TIMBER YARD #1
3 BUFFELEN WOODWORKING CO
4 HYDRO SYSTEMS ENGINEERING
[illegible] MARINE INC
5 KNAPP BOAT BUILDING
6 HARBOR SERVICE
HYLEBOS MARINA
HYLEBOS BOAT HAVEN
7 JONES CHEMICAL
8 GENERAL METALS INC
9 TACOMA BOATBUILDING
10 MANKE LUMBER
11 MARINE METAL MFG
12 JONES GOODELL CORP
13 MARINE METALS
MARINE SUPPLY
14 [illegible] INC
15 REPUBLIC SUPPLY CO
[illegible]
16 [illegible]
17 LOUISIANA PACIFIC
18 GLACIER SAND & GRAVEL
19 KAISER ALUMINUM & CHEMICAL
20 BONNEVILLE POWER ADMIN
21 CITY OF TACOMA SUBSTATION
22 PORTAC, INC
23 WEYERHAEUSER
24 DUNLAP TOWING
25 CASCADE TIMBER YARD #2
26 PETROLEUM RECLAIMING SERVICE, INC
27 PENNWALT CHEMICAL CORP
28 PENNWALT AGCHEM DIV
29 [illegible] PRODUCTS INC
[illegible] TRANSPORT
30 REICHHOLD CHEMICAL
31 REICHHOLD CHEMICAL
32 PUGET CHEMICAL CO
33 WESTERN TURNING
34 [illegible] PIPE
35 [illegible]
36 ACCURATE PACKAGING INC
[illegible]
TACOMA BOAT CO
37 PACIFIC PAPER PRODUCTS
38 STANDARD MECHANICAL INC
39 LINCO ENGINEERING
40 CHEMICAL PROCESSORS
41 BRAZIER LUMBER
42 CITY OF TACOMA FIRE STATION
43 P G CORP
44 MISC COMMERCIAL BUSINESSES
45 U S GYPSUM
46 MURRAY PACIFIC YARD #1
47 BUFFELEN WOODWORKING CO
48 [illegible] PLANT
49 [illegible] BOAT CO INC
50 [illegible] STEEL LOCOMOTIVES
51 BRAZIER LUMBER
52 CITY OF TACOMA
53 NAVAL [illegible]
54 NAVAL [illegible]
55 TACOMA BOAT BUILDING CO
56 [illegible] INC
57 [illegible]
58 OCCIDENTAL CHEMICAL CORP
59 PORT OF TACOMA [illegible]
60 TACOMA BOATBUILDING CO
61 COMMENCEMENT BAY [illegible]
0 1000
0 500
Reference: Tacoma Pierce County Health Department (1984-1986)
Notes: Property boundaries are approximate based on aerial photographs and drive by inspections

Reference: Tetra Tech (1986), TPCHD (1984-1986)

Figure C.2. Hylebos Waterway - Existing industries and businesses

Remedial activities at Pennwalt Chemical Corporation are regulated by both a consent decree signed in July 1987 and a stipulated agreement issued in March 1989. The decree requires the following:

- Characterization of the Pennite area (sludge, soil, and shallow groundwater)
- Characterization of the Wypenn area (soil and groundwater)
- Surface impoundment sampling and analysis
- Surface water quality sampling and analysis
- Following completion of characterization of the Pennite area, preparation of recommendations for mitigating arsenic contamination in the upper aquifer and implementation of the approved alternative.

Soil sampling and analysis plans for the Wypenn and Pennite areas were submitted in December 1987, and soil sampling at the Pennite area was completed in early 1988. The Wypenn soil sampling plan was approved in May 1989. The surface water quality and impoundment sampling plans were submitted to Ecology in August 1987. These plans were revised in May 1989 and will be completed by October 1989. A groundwater characterization report and an engineering evaluation work plan to mitigate arsenic contamination in the upper aquifer in the vicinity of the Pennite area were submitted in December 1987. The arsenic remediation feasibility study/remedial design work plan was approved in May 1989, and a completed feasibility study/remedial design for the Pennite area is expected in February 1990. Remedial action should begin in spring 1990 and require 1 year to complete. Construction on a new caustic tank farm facility began in January 1989 and will be finished in October 1989.

An administrative order issued in February 1988 addresses the extreme pH variations in the Pennwalt effluent. The order requires that Pennwalt either comply with dangerous waste permit-by-rule regulations or meet the exemption requirements. The administrative order has been superseded by a stipulated agreement signed in March 1989. Under the stipulated agreement, Pennwalt must meet the following requirements:

- Pay penalties for pH exceedance in the outfall
- Make interim and final upgrades to the pH neutralization system.

The interim neutralization system has been in place and operating effectively since June 1989. The final neutralization system must be operable prior to an NPDES permit renewal in August 1990.

No ongoing sources of polychlorinated biphenyls (PCBs) were identified in the CB/NT remedial investigation at General Metals, Inc. However, a subsequent PCB reconnaissance survey completed in July 1986 found elevated levels of PCBs (Stinson et al. 1987). Activities at the site are being conducted under an Ecology administrative order issued in August 1987 that requires General Metals to remove inactive PCB transformers and submit a work plan for complete site characterization. In February 1988, a work plan for site characterization and interim remedial action was submitted, and the order was amended to require that a conceptual site drainage plan be submitted and that source control remedial action be initiated. The preliminary remedial investigation was conducted between March and July 1988 and the continuing remedial investigation was submitted to Ecology in June 1989. A site stabilization plan was submitted to Ecology in September 1988, and Ecology amended the order to require implementation of the plan and preparation of a source control feasibility study. The source control feasibility study began in December 1988 and was completed in July 1989. Further source control activities after December 1989 will be enforced by an agreement or order which should be signed in October 1989. Various types of site stabilization activities began in March 1988 and continued until June 1989.

Remedial actions at the 3009 Taylor Way log sorting yard are regulated by a consent order signed in June 1987 between Ecology and the Pennwalt Chemical Corporation (the property owner). The order requires Pennwalt to prepare an engineering evaluation (surface water investigation) and conduct a remedial investigation/feasibility study at the site. Work plans for an engineering evaluation and a remedial investigation/feasibility study were submitted to Ecology in July and August 1987, respectively. Between July 1987 and January 1988 the surface water investigation was completed. A focused feasibility study submitted in March 1988 indicated that interim remedial action would not be required. Ecology has concurred with this conclusion and determined that remedial action will await the results of the remedial investigation/feasibility study. The remedial investigation work plan was approved in December 1987, and the remedial investigation began in February 1988. Between February and March 1988, the hazardous substances and hydrogeological investigations were completed. Wet weather sampling was completed in the spring of 1988. The submittal date of the final feasibility study is a negotiated item under the 1987 consent order. The remedial design/remedial action phase will be handled by either an amended or a new consent decree. The new consent decree will be consistent with the applicable or relevant and appropriate requirements (ARARs) of the Model Toxics Control Act and should be signed during the summer of 1990.

Activities at the Wasser Winters log sorting yard are regulated by a consent order, signed in March 1987, between Ecology and the Port of Tacoma (the property owner). A preliminary site characterization was completed in April 1987. In August 1987, a proposal by the Port of Tacoma to mitigate soils slag and wood waste onsite was submitted to Ecology and rejected. In January 1988, the Port of Tacoma agreed to prepare a proposal for an alternative remedial design incorporating mitigation of both surface water and groundwater contamination. This remedial design should be finished by February 1990. Remedial action should begin in March 1990 and be completed by December 1990.

Ecology issued an administrative order in June 1987 that requires Louisiana-Pacific log sorting yard to perform a site investigation and feasibility study. A surface water drainage study was completed in October 1987. A work plan for groundwater characterization was submitted by the PRP in November 1988. Groundwater characterization, which began in September 1988, includes installation of three monitoring wells, one round of sampling, and a tidal study. Groundwater sampling will be followed by groundwater monitoring. The feasibility study work plan was submitted to Ecology in January 1988, the draft feasibility study was submitted in September 1988, and the final feasibility study was submitted in February 1989. An addendum to the feasibility study was completed by Ecology in June 1989 to address several issues of concern not previously addressed. Remedial action should begin in June 1990 and be completed by October 1990.

Remedial action at Cascade Timber Yard #2 is regulated by the Puyallup Tribe settlement agreement. It is anticipated that this agreement will become effective in February 1990. Under the agreement, the Port of Tacoma must perform an environmental audit and prepare a cleanup plan. The environmental audit began in April 1989, and the sampling plan section of this audit will begin in October 1989. The Port of Tacoma has 3 years from the effective date of the agreement to complete the cleanup.

Remedial action at B&L Landfill is driven by a consent decree completed in February 1989. The consent decree requires a remedial investigation/feasibility study/remedial design by May 1990. The final remedial investigation should be completed in early 1990. Under an extension currently being negotiated, the final remedial action/remedial design will be completed in June 1990. The remedial action will require an amended or new consent decree. Of the nine PRP that have been identified, one PRP (Murray Pacific) has agreed to complete the remedial action if 30 percent matching public funds are provided.

Remedial activities at Tacoma Boatbuilding Company are driven by the Shipyard Education Program and the related NPDES permits being issued by Ecology and an administrative order effective July 1989. The Shipyard Education Program, currently underway, is designed to provide shipyard operators with information on appropriate best management practices. The NPDES permit will be issued in December 1989. The NPDES permit and the administrative order will require that best management practices be implemented, monitored, and documented. Best management practices will include routine cleaning of the yard area; appropriate storage of paints, solvents, and other chemicals; the use of drip pans and containment structures to minimize dispersion of potentially hazardous solutions and dust; constraints on bilge and ballast water discharge; and explicit limitations on the discharge of all oil or hazardous material to the waterway.

USG Landfill has been associated with contamination in sediments at the Head of Hylebos Waterway but is not specifically included in the schedules because of a lack of recent activity. Remedial actions at USG Landfill are mainly historical and include excavation and removal of waste and capping of the site. Groundwater at the site is currently monitored, and no additional remedial activities are scheduled.

MOUTH OF HYLEBOS WATERWAY

The locations of existing industries, businesses, and discharges in Hylebos Waterway are shown in Figure C-2. Remedial activities at the Mouth of Hylebos Waterway are summarized in Figure C-3. Occidental Chemical is the major identified source of problem chemicals in this problem area. Several source control actions have been undertaken by Occidental Chemical in the past several years. In-plant modifications include the installation of taller chlorine stripping towers along with modifications in temperature regulation and modified waste handling practices. Effluent from the facility is monitored under an NPDES permit, which is due for renewal in March 1990. Most of the soil characterization was conducted in 1979. More than 10,000 cubic yards of soil contaminated with chlorinated organic compounds were removed from the site during 1981-1982, in accordance with a consent order.

Recent, ongoing, and planned activities at Occidental Chemical are driven by a Resource Conservation and Recovery Act (RCRA) Part B permit that specifies sediment sampling and sediment and groundwater remediation. The draft RCRA permit was completed in August 1988. The permit was completed in November 1988. Groundwater monitoring is ongoing, and the installation of six additional shallow wells was completed in September 1988. A sediment sampling plan approved by the U.S. Environmental Protection Agency (EPA) and Ecology in December 1987 is being implemented and a draft report will be completed by September 1989. Also expected in September 1989 is a draft groundwater corrective action plan for a groundwater extraction and treatment system. Construction on the extraction and treatment systems should begin early in 1991 and require a minimum of 8 months to complete.

SITCUM WATERWAY

The locations of existing industries, businesses, and discharges in Sitcum Waterway are shown in Figure C-4. Remedial activities in Sitcum Waterway are directed at Terminal 7 ore unloading facilities and Storm Drain SI-172, two primary sources of metals (Figure C-5). Remedial actions at Terminal 7 are limited to the implementation of best management practices. Spilled ore, which was formerly swept into the waterway, is now collected and sold to smelters. A closed conveyer belt is now used for transferring alumina ore from ships to storage areas. Best management practices are subject to routine monitoring to ensure that discharge of ore to the waterway is minimized. Routine monitoring (conducted as of July 1989) indicates that best management practices are being followed.

Storm Drain SI-172 is one of five storm drains in the CB/NT area included in the pollution control effort being implemented under the memorandum of agreement between Ecology, the city of Tacoma, and the Tacoma-Pierce County Health Department (TPCHD). The storm drain report required by the agreement was completed in July 1989. Between January 1987 and December 1988, chemical loading from the drain was monitored quarterly during high- and low-flow conditions. Also during this study period, business inspections were conducted to better characterize activities

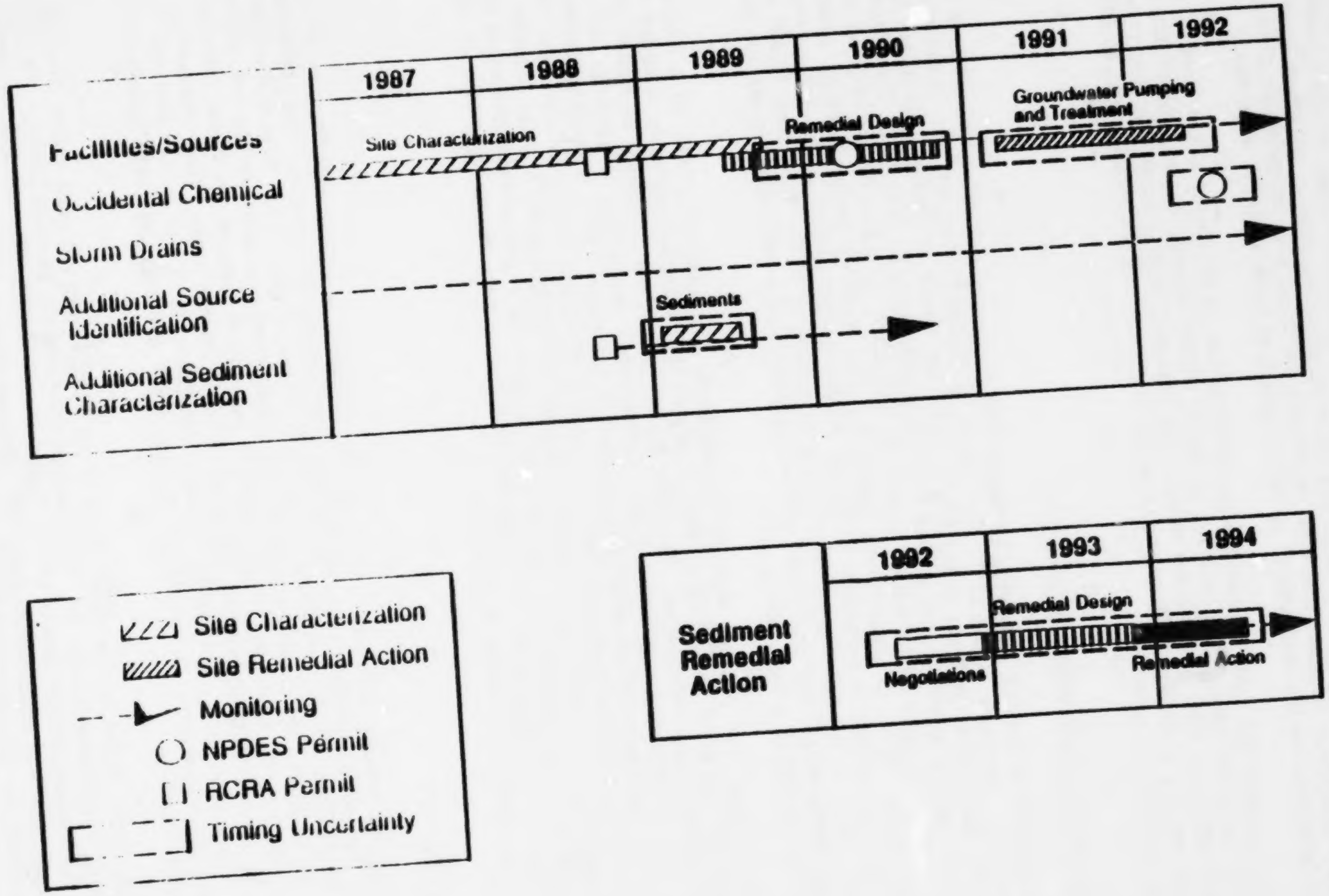
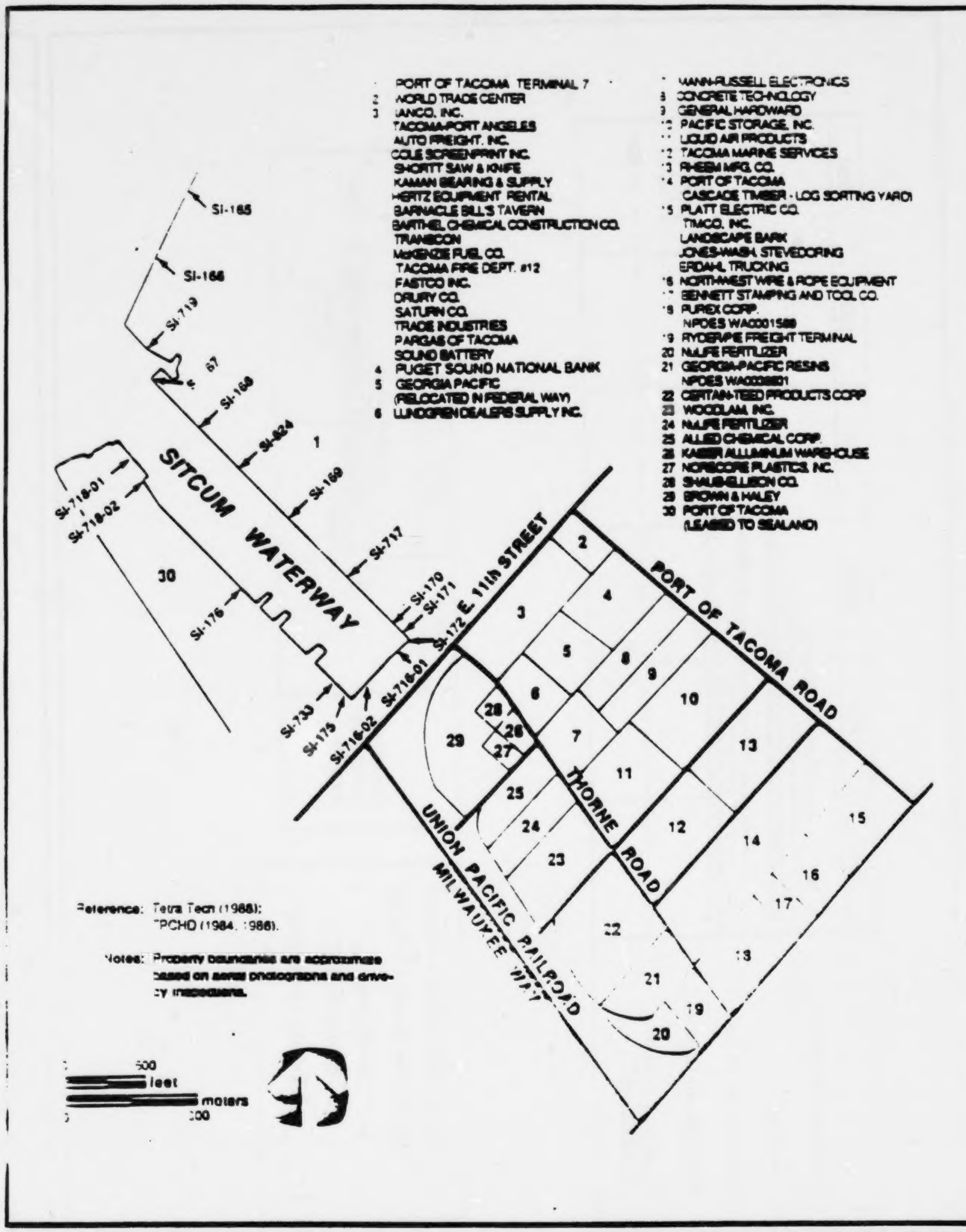


Figure C-3. Recent, ongoing, and planned activities at the Mouth of Hylebos Waterway


1 PORT OF TACOMA TERMINAL 7
2 WORLD TRADE CENTER
3 IANCO, INC.
TACOMA-PORT ANGELES
AUTO FREIGHT, INC.
COLE SCREENPRINT INC.
SHORTT SAW & KNIFE
KAMAN BEARING & SUPPLY
HERTZ EQUIPMENT RENTAL
BARNACLE BILL'S TAVERN
BARTHEL CHEMICAL CONSTRUCTION CO.
TRANSCON
McKENZIE FUEL CO.
TACOMA FIRE DEPT. #12
FASTCO INC.
DRURY CO.
SATURN CO.
TRADE INDUSTRIES
PARGAS OF TACOMA
SOUND BATTERY
4 PUGET SOUND NATIONAL BANK
5 GEORGIA PACIFIC
(RELOCATED IN FEDERAL WAY)
6 LUNDGREN DEALERS SUPPLY INC.
7 WANN-RUSSELL ELECTRONICS
8 CONCRETE TECHNOLOGY
9 GENERAL HARDWARD
10 PACIFIC STORAGE, INC.
11 LIQUID AIR PRODUCTS
12 TACOMA MARINE SERVICES
13 RHEEM MFG. CO.
14 PORT OF TACOMA
CASCADE TIMBER - LOG SORTING YARD)
15 PLATT ELECTRIC CO.
TIMCO, INC.
LANDSCAPE BARK
JONES-WASH. STEVEDORING
ERDAHL TRUCKING
16 NORTHWEST WIRE & ROPE EQUIPMENT
17 BENNETT STAMPING AND TOOL CO.
18 PUREX CORP.
NPDES WA0001589
19 RYDER/PIE FREIGHT TERMINAL
20 NULIFE FERTILIZER
21 GEORGIA-PACIFIC RESINS
NPDES WA0000801
22 CERTAIN-TEED PRODUCTS CORP
23 WOODLAM, INC.
24 NULIFE FERTILIZER
25 ALLIED CHEMICAL CORP.
26 KAISER ALLUMINUM WAREHOUSE
27 NORSCORE PLASTICS, INC.
28 SHAUB-ELLISON CO.
29 BROWN & HALEY
30 PORT OF TACOMA
(LEASED TO SEALAND)
SI-165
SI-166
SI-719
SI-167
SI-168
SI-824
1
SI-169
SI-717
SITCUM WATERWAY
SI-718-01
SI-718-02
30
SI-176
SI-170
SI-171
SI-172
E. 11th STREET
SI-716-01
SI-733
SI-175
SI-716-02
PORT OF TACOMA ROAD
THORNE ROAD
UNION PACIFIC RAILROAD
MILWAUKEE WAY
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
0
500
feet
meters
0
200

Reference: Tetra Tech (1988); TPCHD (1984, 1986).

Notes: Property boundaries are approximate based on aerial photographs and drive-by inspections.

Figure C-4. Sitcum Waterway - Existing industries, businesses, and discharges

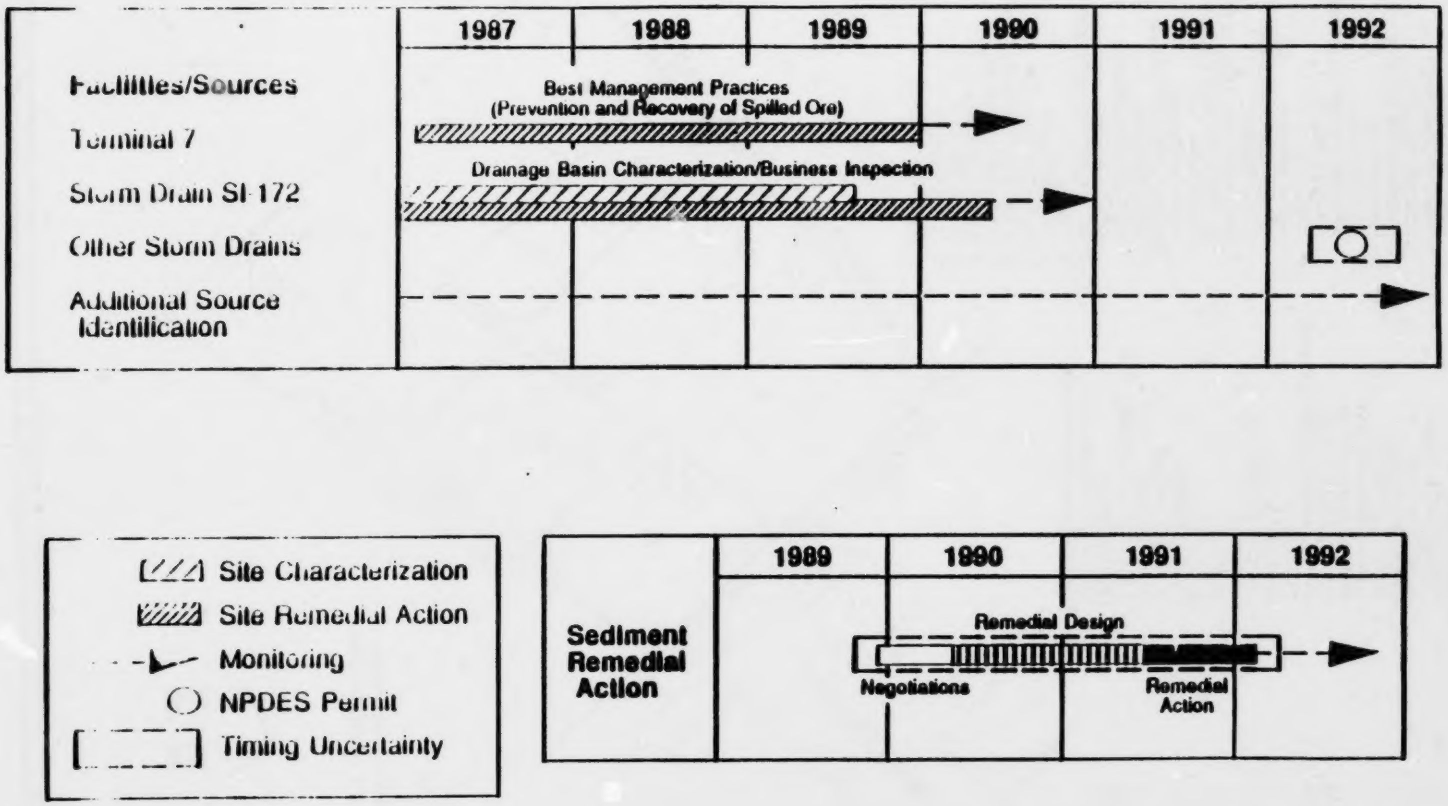


Figure C 5 Recent, ongoing, and planned activities in Sitcum Waterway and implement appropriate corrective actions. Business inspections and storm drain monitoring have been extended until April 1990.

Significant source controls in Sitcum Waterway have been implemented, but their effectiveness has not yet verified.

At the time of this writing, the Port of Tacoma has plans to dredge over 40,000 cubic yards of material for maintenance and extension of Pier 1. Habitat replacement at the head of the waterway and a fish mitigation area are elements of the planned dredging. The navigational channel in Sitcum Waterway is also subject to routine dredging. Where possible, these dredging projects will be integrated into the implementation of the preferred sediment remedial alternative. Re-evaluation of the dredging schedule and resource availability may necessitate modification of the schedule for sediment remedial action.

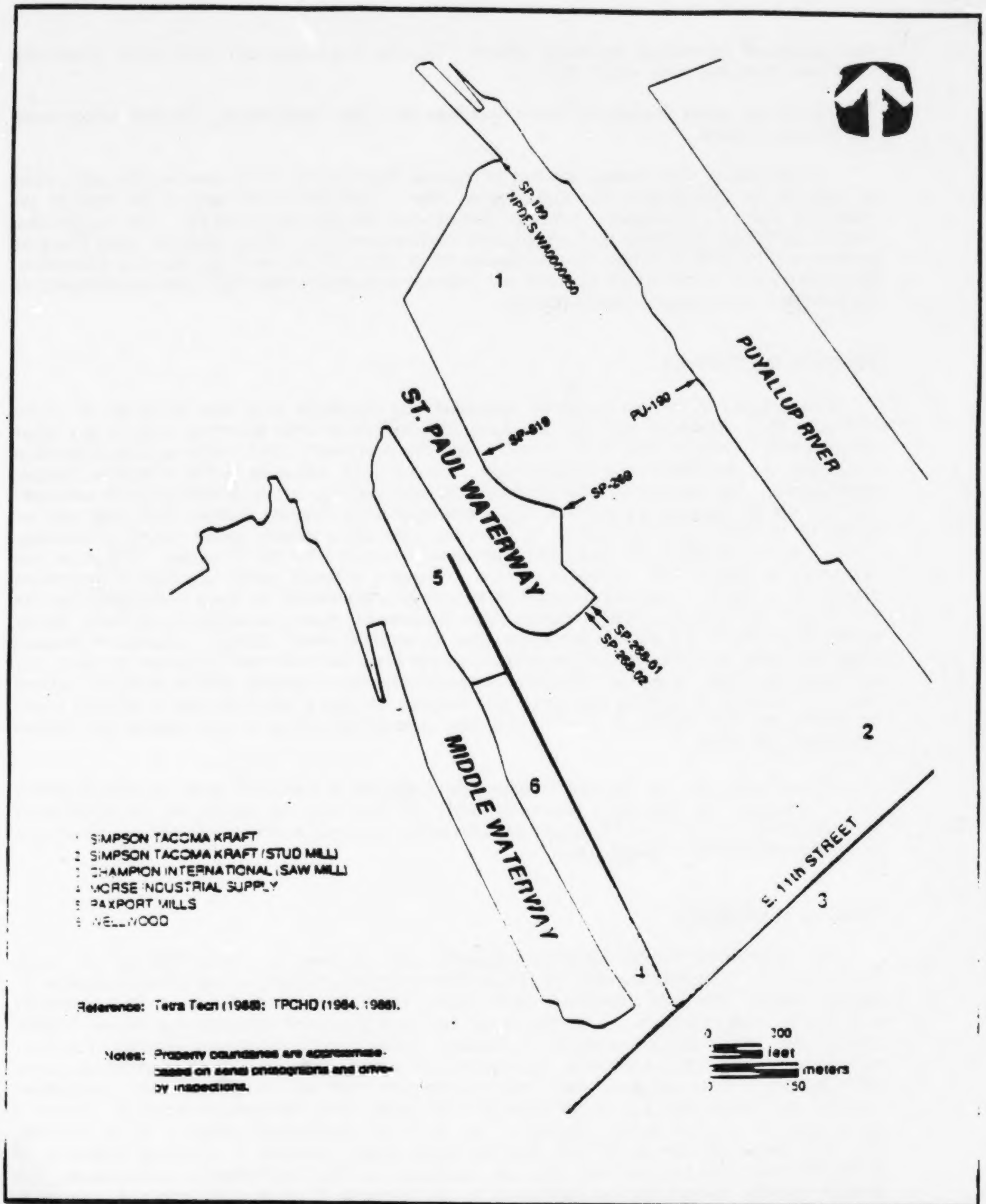
ST. PAUL WATERWAY

The locations of existing industries, businesses, and discharges in St. Paul Waterway are shown in Figure C-6. Remedial activities are more advanced in St. Paul Waterway than in any other problem area. Simpson Tacoma Kraft pulp mill, the waterway's single major source of problem chemicals, has implemented numerous source control actions, including outfall relocation, process modifications, and best management practices. Recent, ongoing, and scheduled activities associated with the site are summarized in Figure C-7. Activities at the Simpson Tacoma Kraft pulp mill are driven by an order issued by Ecology in December 1985 and a consent decree signed in December 1987. The relocation of the treatment plant outfall required by the December 1985 order was completed in March 1988. Simpson also has initiated a remedial action and habitat restoration program in an effort to remediate sediments previously contaminated by waste discharged from the site. Under the December 1987 consent decree, Simpson has deposited sediments displaced during relocation activities in a shallow depression near the original outfall location. Capping of this and other sediments contaminated by historical discharge from the plant was conducted between July and September 1988. A habitat restoration program designed to mitigate adverse biological impacts was a key element of capping activities. The Simpson Tacoma Kraft Company is required under the December 1987 decree to monitor the long-term effectiveness of the capping and habitat restoration activities.

The effluent from the Simpson Tacoma Kraft pulp mill is monitored under an NPDES permit that is scheduled for renewal in December 1989. At that time, the permit may be modified to expand restrictions on toxic chemicals not previously covered in the permit and to incorporate additional monitoring requirements.

MIDDLE WATERWAY

The locations of existing industries, businesses, and discharges in Middle Waterway are shown in Figure C-8. Remedial activities in Middle Waterway have focused on two potential sources of metals, Marine Industries Northwest and Cooks Marine Specialties (Figure C-9). Remedial activities at these shipyards are driven by the Shipyard Education Program and related NPDES permits that are being implemented by Ecology. The Shipyard Education Program (currently underway) is designed to disseminate appropriate best management practices to shipyard operators. NPDES permits to be issued to these sites in December 1989 will require that best management practices be implemented and documented by monitoring. Best management practices covered in the permit will include routine cleaning of the yard area; appropriate storage of paints, solvents, and other chemicals; the use of drip pans and containment structures to minimize dispersion of potentially hazardous solutions and dust; and constraints on bilge and ballast water discharge. The permits will also include explicit limitations on the discharge of all oil and hazardous material to the waterway.


SP-180
NPDES WA0000850
1
PU-190
PUYALLUP RIVER
ST. PAUL WATERWAY
SP-619
SP-250
SP-268-01
SP-268-02
5
6
MIDDLE WATERWAY
2
S. 11th STREET
3
4
0 200 feet
0 50 meters
1 SIMPSON TACOMA KRAFT
2 SIMPSON TACOMA KRAFT (STUD MILL)
3 CHAMPION INTERNATIONAL (SAW MILL)
4 MORSE INDUSTRIAL SUPPLY
5 PAXPORT MILLS
6 WELLWOOD

Reference: Tetra Tech (1988); TPCHD (1984, 1986).

Notes: Property boundaries are approximate based on aerial photographs and drive-by inspections.

Figure C-6. St. Paul Waterway - Existing industries, businesses, and discharges

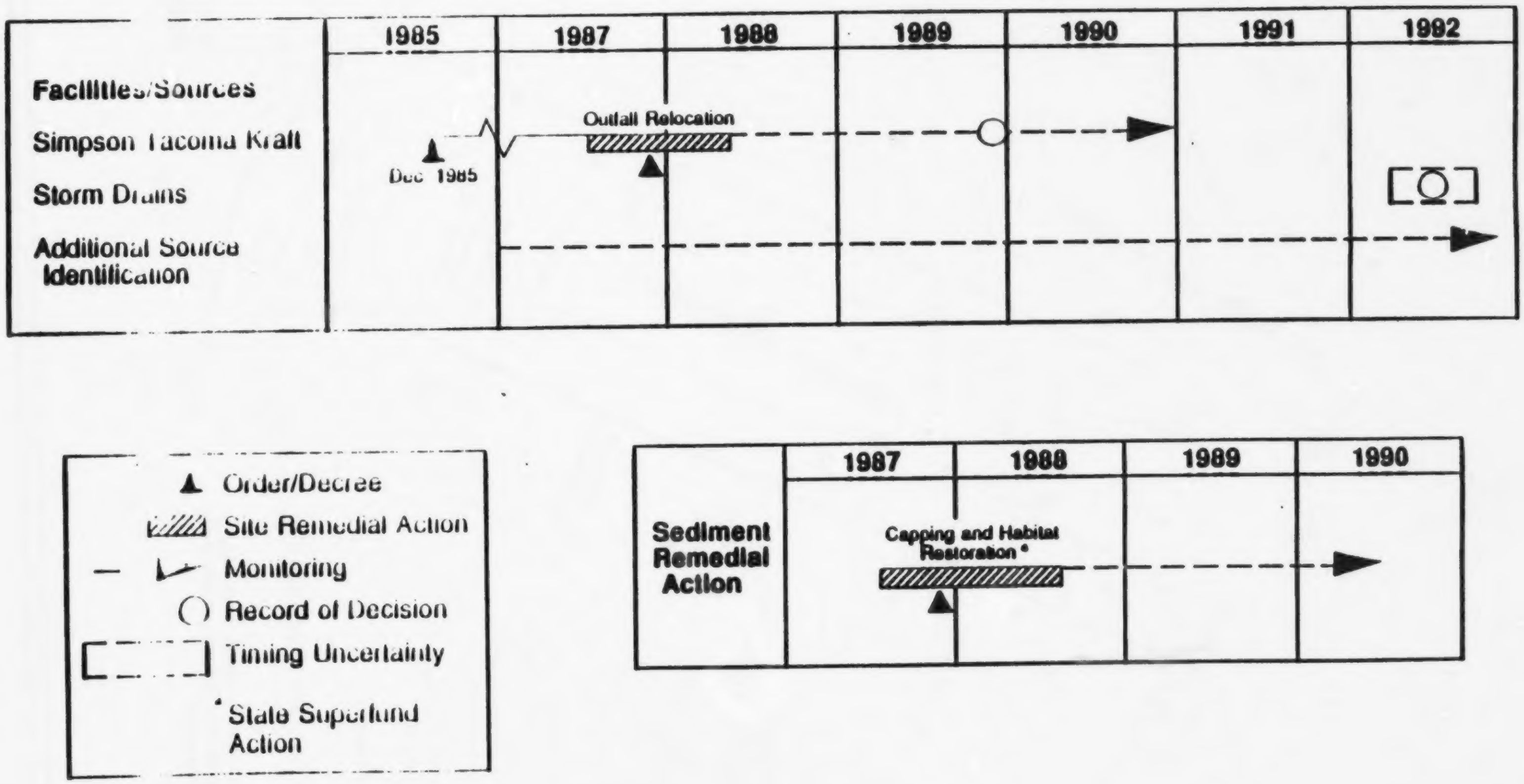


Figure C 7 Recent, ongoing, and planned activities in St. Paul Waterway

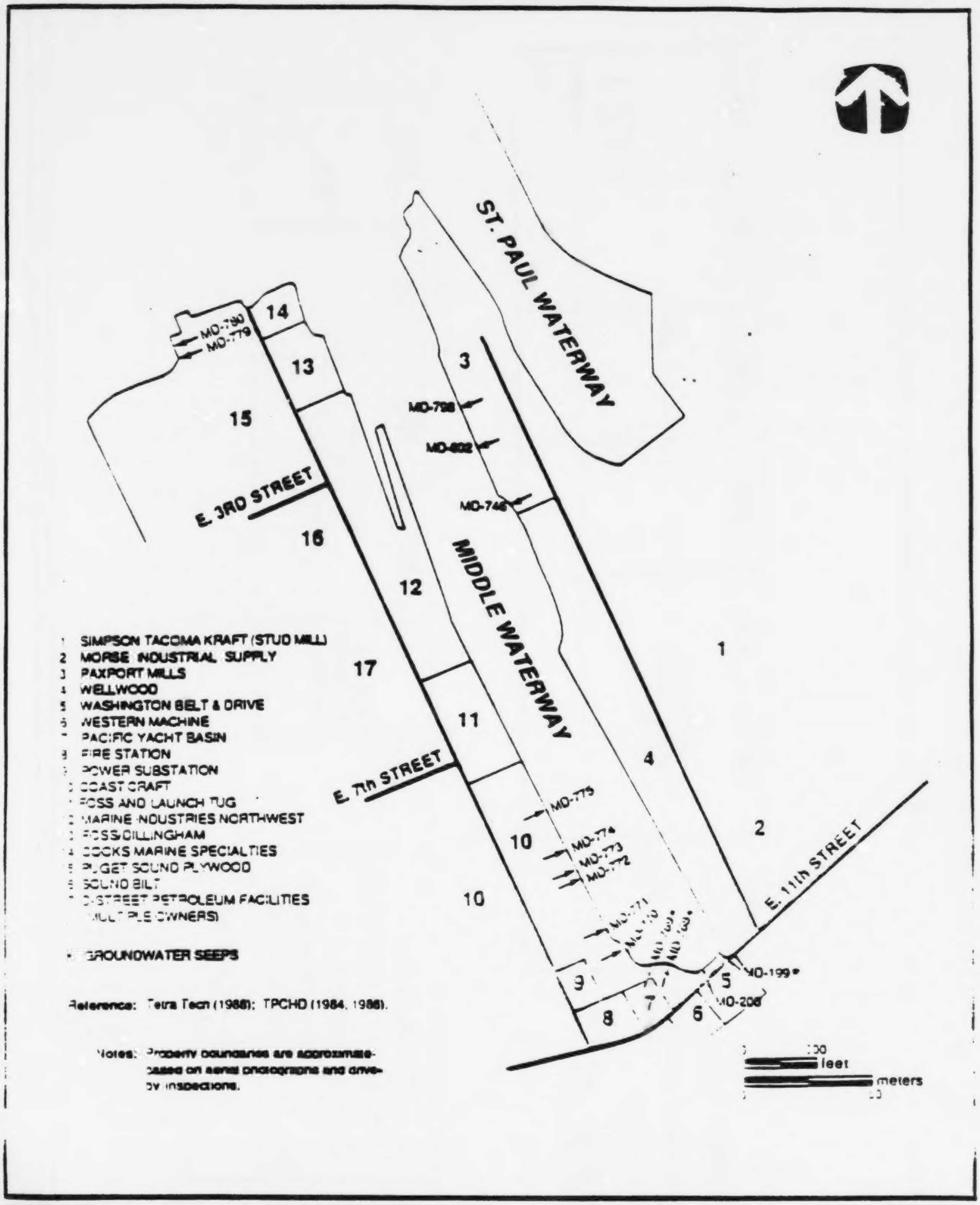

ST. PAUL WATERWAY
MIDDLE WATERWAY
E. 3RD STREET
E. 7th STREET
E. 11th STREET
MD-780
MD-779
MD-798
MD-802
MD-746
MD-775
MD-774
MD-773
MD-772
MD-771
MD-199
MD-208
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
1 SIMPSON TACOMA KRAFT (STUD MILL)
2 MORSE INDUSTRIAL SUPPLY
3 PAXPORT MILLS
4 WELLWOOD
5 WASHINGTON BELT & DRIVE
6 WESTERN MACHINE
7 PACIFIC YACHT BASIN
8 FIRE STATION
9 POWER SUBSTATION
10 COAST CRAFT
11 FOSS AND LAUNCH TUG
12 MARINE INDUSTRIES NORTHWEST
13 FOSS/DILLINGHAM
14 COCKS MARINE SPECIALTIES
15 PUGET SOUND PLYWOOD
16 SOUND BILT
17 D-STREET PETROLEUM FACILITIES (MULTIPLE OWNERS)
• GROUNDWATER SEEPS
Reference: Tetra Tech (1988); TPCHD (1984, 1986).
Notes: Property boundaries are approximate-based on aerial photographs and drive-by inspections.
feet
meters

Figure C-8. Middle Waterway - Existing industries, businesses, and discharges

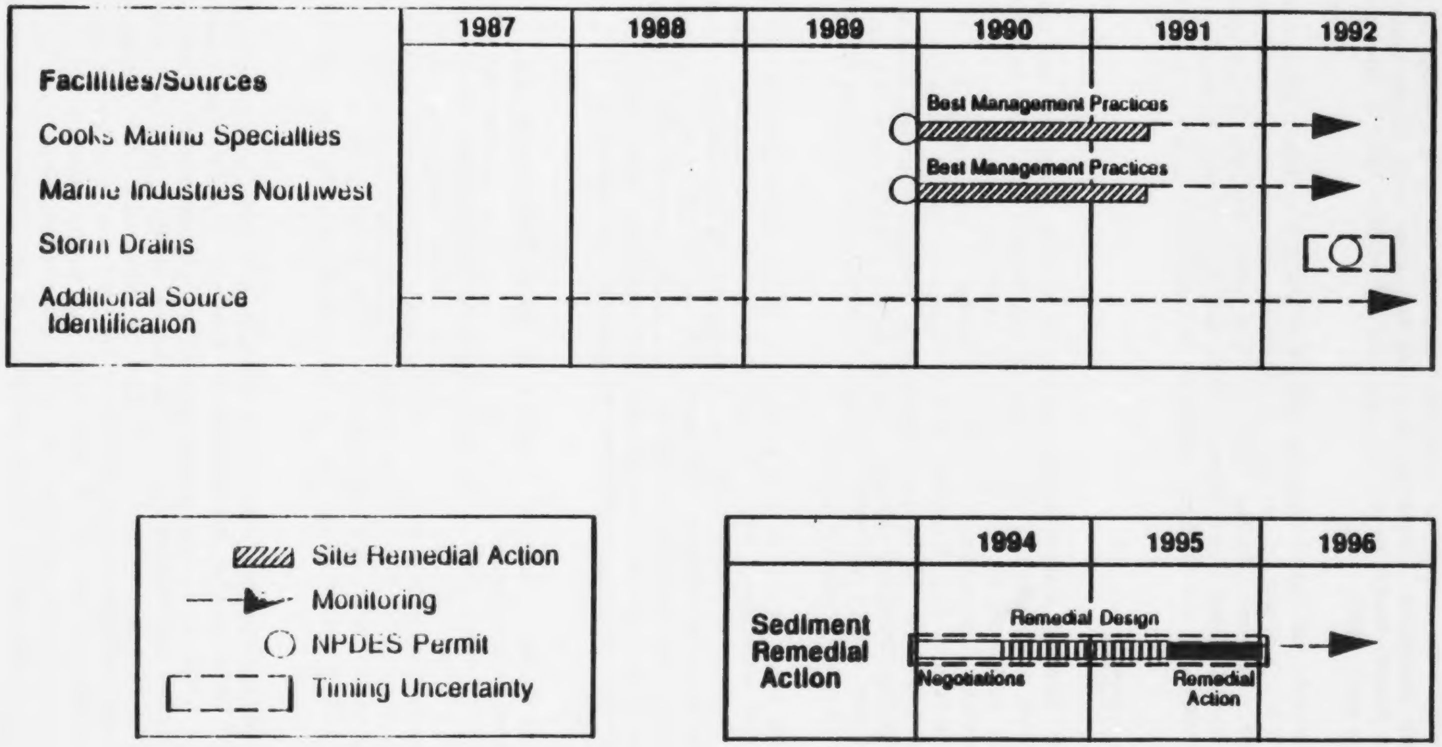


Figure C-9. Recent, ongoing, and planned activities in Middle Waterway

Storm Drain MD-200 was identified as a probable source of lower priority organic chemicals at the head of the waterway. Sediments in Storm Drain MD-200 were sampled in June 1987 and analyzed for problem chemicals. Remedial activities associated with Storm Drain MD-200 and other storm drains in Middle Waterway will be regulated by the new NPDES permit regulations that should be adopted in early 1990.

It is uncertain whether all major ongoing sources of contamination to Middle Waterway have been identified. The effectiveness of the best management practices implemented at the shipyards has not been verified. Between October 1989 and June 1990, inspections are schedule for Foss and Launch Tug Industries, Coast Craft, Paxport Mills, and Puget Sound Plywood. However, there is currently no indication that any of these businesses is a source of pollution to Middle Waterway.

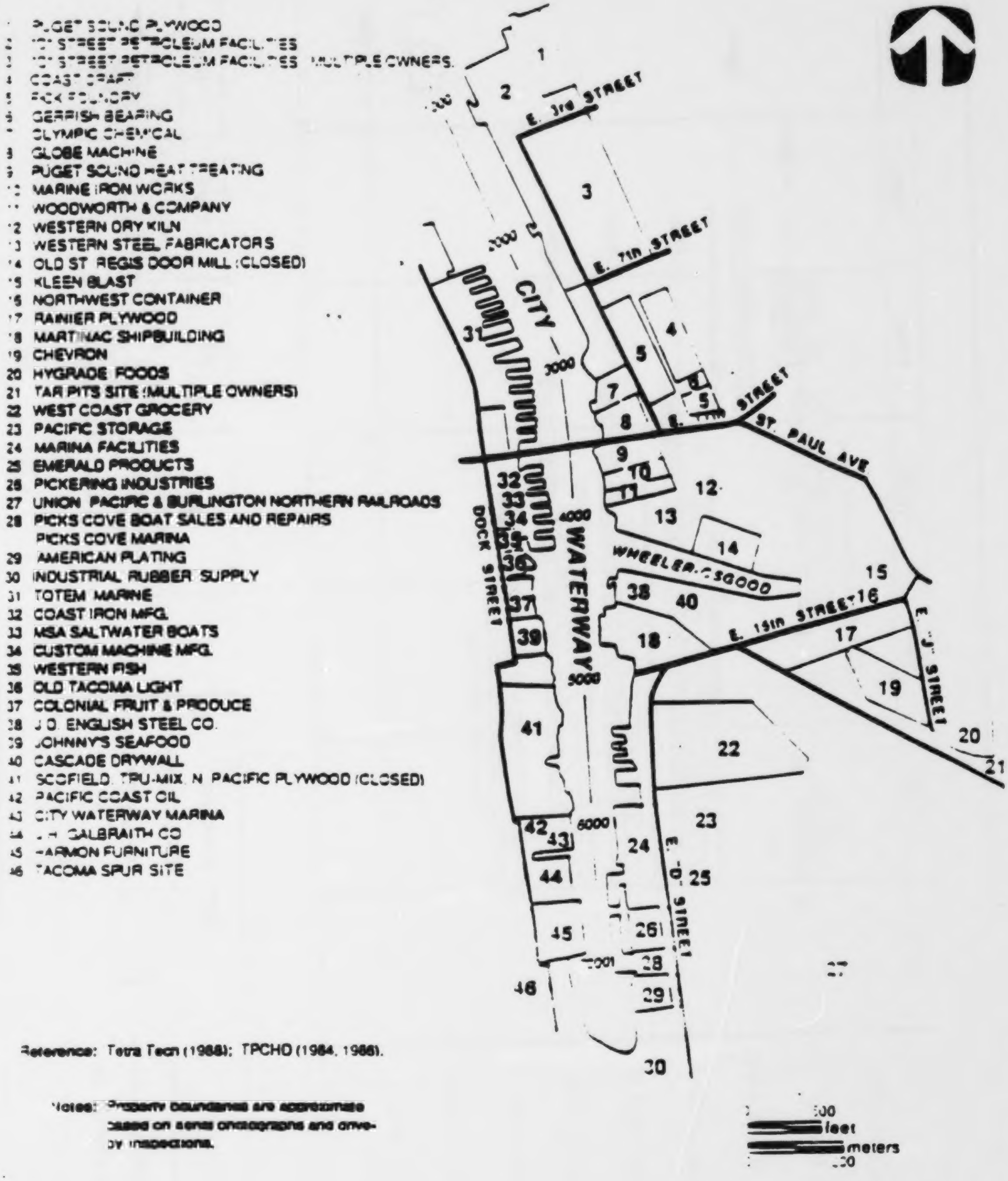
HEAD OF CITY WATERWAY

The locations of existing industries and businesses in City Waterway are shown in Figure C-10. Remedial actions are underway for several of the sources that have been associated with problem chemicals in sediments at the Head of City Waterway (Figure C-11). City Waterway Marina, Inc. and Martinac Shipbuilding have plans to dredge in the near future. The navigational channel running the length of City Waterway is also subject to routine dredging. When possible, remedial action implementation will be coordinated with planned dredging within the waterway. Major sources of problem chemicals include: Storm Drains CS-237, CN-237, and CI-230 (e.g., metals and high molecular weight polycyclic aromatic hydrocarbons); Martinac Shipbuilding (metals only); and American Plating (primarily nickel).

American Plating is no longer an active facility. When active, the site was designated an RCRA dangerous waste generator. After the site became inactive, Ecology negotiated consent orders to mitigate contamination problems onsite. Emergency site stabilization at American Plating was performed by the site owner under a November 1986 consent order and was completed in June 1987. A second consent order signed in September 1987 stipulates additional site characterization, including 1) the chemical and spatial characterization of remaining waste onsite, 2) determination of the integrity of sumps, and 3) groundwater monitoring. In September 1987, EPA issued a RCRA enforcement order.

Ongoing remedial action at the site is driven by the RCRA closure process and the state Superfund law. A remedial investigation work plan was submitted to Ecology and EPA in February 1988 and was approved in April 1988. The draft remedial investigation report was submitted in July 1988. However, a preliminary review revealed several data gaps, particularly in the characterization of the vertical extent of soil contamination. An acceptable remedial investigation report was received in May 1989. The RCRA corrective action order is expected by October 1989. A corrective measures study will begin once the corrective action order is finalized in October 1989. The remedial action should begin during the summer of 1990 and require 6 months to complete.

Remedial activities at Martinac Shipbuilding are driven by the Shipyard Education Program and the related NPDES permits being implemented by Ecology. The Shipyard Education Program (currently underway) is designed to disseminate appropriate best management practices to shipyard operators. NPDES permit applications to be finalized in January 1990 will require that best management practices be implemented and documented by monitoring. Best management practices covered in the permit will include routine cleaning of the yard area; appropriate storage of paints, solvents, and other chemicals; the use of drip pans and containment structures to minimize dispersion of potentially hazardous solutions and dust; and constraints on bilge and ballast water discharge. The permit will also include explicit limitations on the discharge of all oil and hazardous material to the waterway.



1
2
3
4
5
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
27
E. 3rd STREET
E. 7th STREET
E. 11th STREET
ST. PAUL AVE
WHEELER-OSGOOD
E. 15th STREET
E. "J" STREET
E. "D" STREET
DOCK STREET
CITY WATERWAY
1000
2000
3000
4000
5000
6000
7001
0 500 feet
meters 100

1 PUGET SOUND PLYWOOD
2 [illegible] STREET PETROLEUM FACILITIES
3 [illegible] STREET PETROLEUM FACILITIES (MULTIPLE OWNERS)
4 COAST CRAFT
5 PICK FOUNDRY
6 GERRISH BEARING
7 OLYMPIC CHEMICAL
8 GLOBE MACHINE
9 PUGET SOUND HEAT TREATING
10 MARINE IRON WORKS
11 WOODWORTH & COMPANY
12 WESTERN DRY KILN
13 WESTERN STEEL FABRICATORS
14 OLD ST. REGIS DOOR MILL (CLOSED)
15 KLEEN BLAST
16 NORTHWEST CONTAINER
17 RAINIER PLYWOOD
18 MARTINAC SHIPBUILDING
19 CHEVRON
20 HYGRADE FOODS
21 TAR PITS SITE (MULTIPLE OWNERS)
22 WEST COAST GROCERY
23 PACIFIC STORAGE
24 MARINA FACILITIES
25 EMERALD PRODUCTS
26 PICKERING INDUSTRIES
27 UNION PACIFIC & BURLINGTON NORTHERN RAILROADS
28 PICKS COVE BOAT SALES AND REPAIRS
PICKS COVE MARINA
29 AMERICAN PLATING
30 INDUSTRIAL RUBBER SUPPLY
31 TOTEM MARINE
32 COAST IRON MFG.
33 MSA SALTWATER BOATS
34 CUSTOM MACHINE MFG.
35 WESTERN FISH
36 OLD TACOMA LIGHT
37 COLONIAL FRUIT & PRODUCE
38 J.D. ENGLISH STEEL CO.
39 JOHNNY'S SEAFOOD
40 CASCADE DRYWALL
41 SCOFIELD, TRU-MIX, N. PACIFIC PLYWOOD (CLOSED)
42 PACIFIC COAST OIL
43 CITY WATERWAY MARINA
44 J.H. GALBRAITH CO
45 HARMON FURNITURE
46 TACOMA SPUR SITE

Reference: Tetra Tech (1988); TPCHD (1984, 1986).

Notes: Property boundaries are approximate based on aerial photographs and drive-by inspections.

Figure C-10. City Waterway - Existing industries, businesses, and discharges

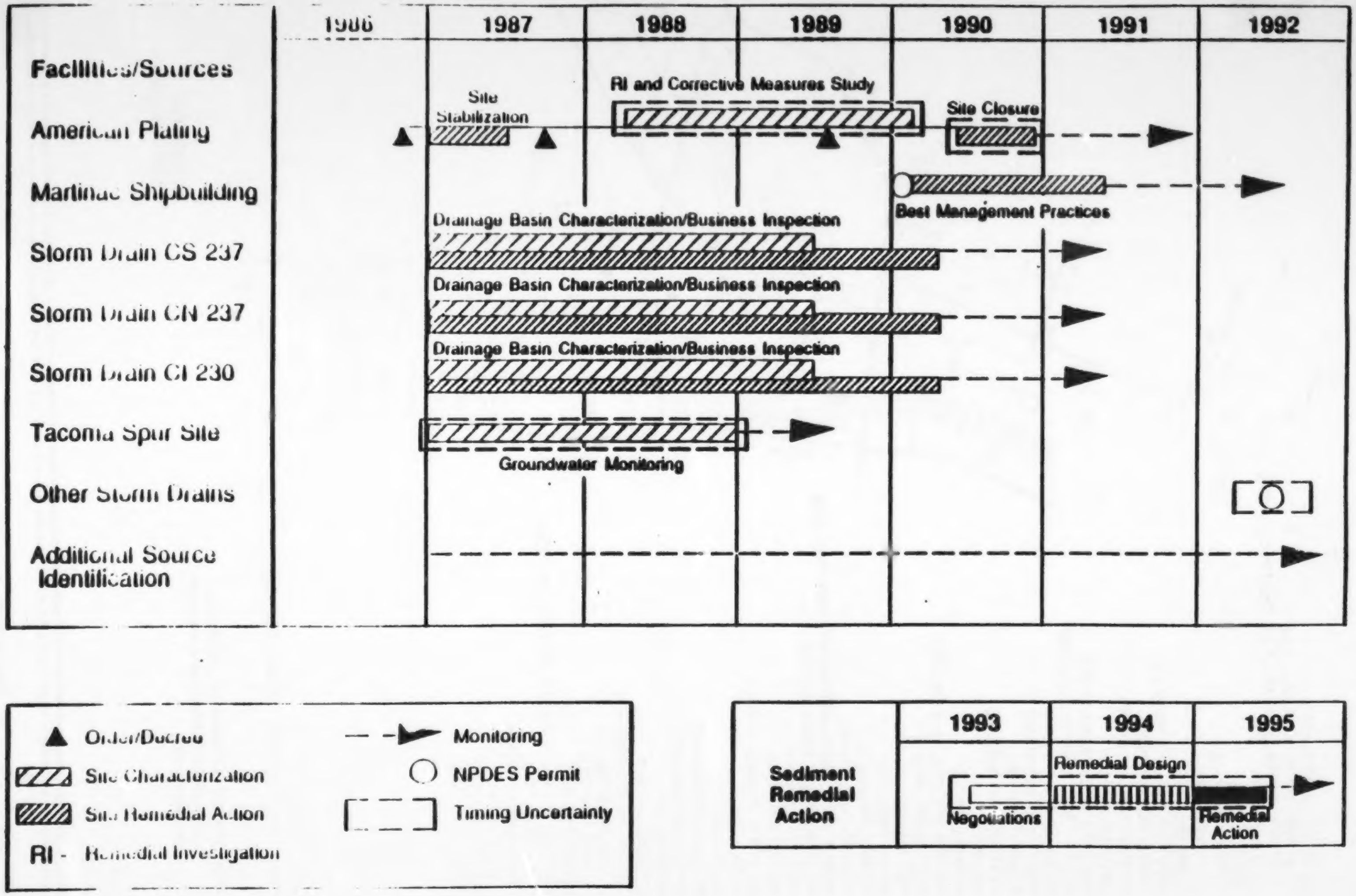


Figure C-11. Recent, ongoing, and planned activities at the Head of City Waterway

Groundwater monitoring is currently being conducted at the Tacoma Spur site. Approximately 17,500 tons of contaminated soils were removed from the site during highway construction. However, no additional remedial action is planned.

Storm Drains CS-237, CN-237, and CI-230 are three of the five CB/NT storm drains included in the pollution control effort being implemented under a memorandum of agreement between Ecology, the city of Tacoma, and the TPCHD. The storm drain report required by the agreement was completed in July 1989. Between January 1987 and December 1988, chemical loading from the drain was measured quarterly for high- and low-flow conditions. Business inspections have been conducted within the drainage basin during this study period to better characterize activities and implement appropriate corrective actions. Monitoring activities have been extended to April 1990. The Tacoma sewer utility is evaluating the feasibility of sediment detection basins to control contaminant discharge into the waterway from Storm Drains CN-237 and CS-237, A report on the sediment detention evaluation will be completed in October 1989.

WHEELER-OSGOOD WATERWAY

The locations of existing industries and businesses in Wheeler-Osgood Waterway are shown in Figure C-10. Remedial activities in Wheeler-Osgood Waterway are summarized in Figure C-12. Storm Drain CW-254 has been identified as the waterway's major ongoing source of problem chemicals. Storm Drain CW-254 is one of five storm drains included in the pollution control effort being implemented under a memorandum of agreement between Ecology, the city of Tacoma, and the TPCHD. The storm drain report required by the agreement was completed in July 1989. Between January 1987 and December 1988, chemical loading from the drain was monitored quarterly for high-and low-flow conditions. Also during this study period, business inspections are conducted within the drainage basin to better characterize activities and implement appropriate corrective actions. Quarterly sampling of the drain has been extended to April 1990.

A separate environmental audit was voluntarily undertaken by Chevron at its bulk plant facility between January and March 1989. The audit indicates that drill cuttings at the site are a source of total petroleum hydrocarbons. A voluntary full-scale investigation and cleanup by Chevron is anticipated.

MOUTH OF CITY WATERWAY

The locations of existing industries and businesses in City Waterway are shown in Figure C-10. Remedial activities at the Mouth of City Waterway are summarized in Figure C-13. The D Street petroleum facilities are an identified source of LPAH in the sediments in this problem area. A trench recovery system was installed as an interim remedial measure between September 1987 and January 1988. This system is expected to affect mainly the surface aquifer near Globe Machine; its effect on property farther north is unknown. Discharged product is also being recovered from wells on Globe Machine and Mobil properties. A consent order issued in November 1988 requires 1) interim remedial action at the site including floating product recovery (already underway) and leak detection/prevention, 2) a remedial investigation of soil, groundwater, surface water, and possibly sediment contamination, and 3) additional remedial action as appropriate.

The remedial investigation report submitted in June 1989 included recommendations that the following tasks be undertaken:

- Floating product plume mapping
- Dissolved contaminant sampling, analysis, and mapping
- Design of an upgraded effluent treatment system.

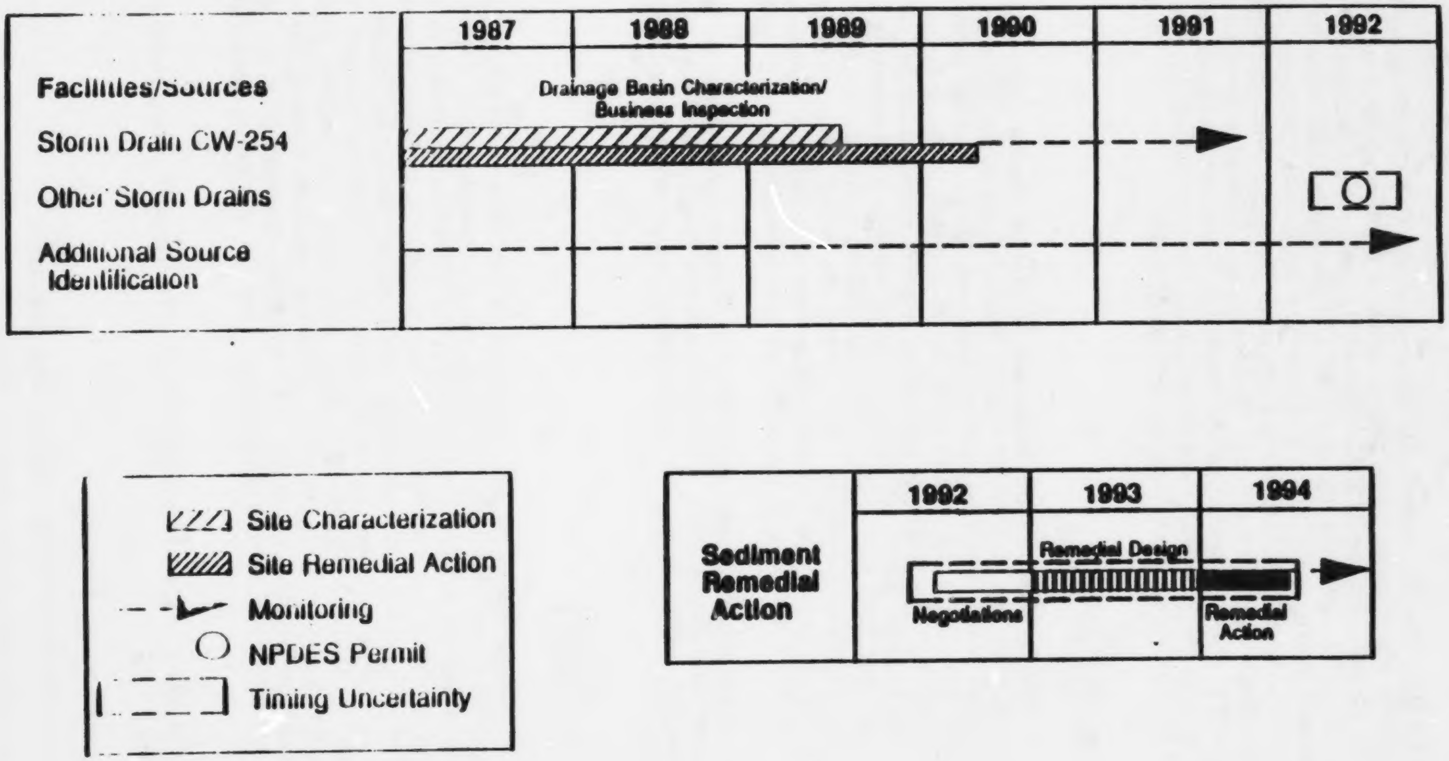


Figure C-12 Recent, ongoing, and planned activities in Wheeler-Osgood Waterway

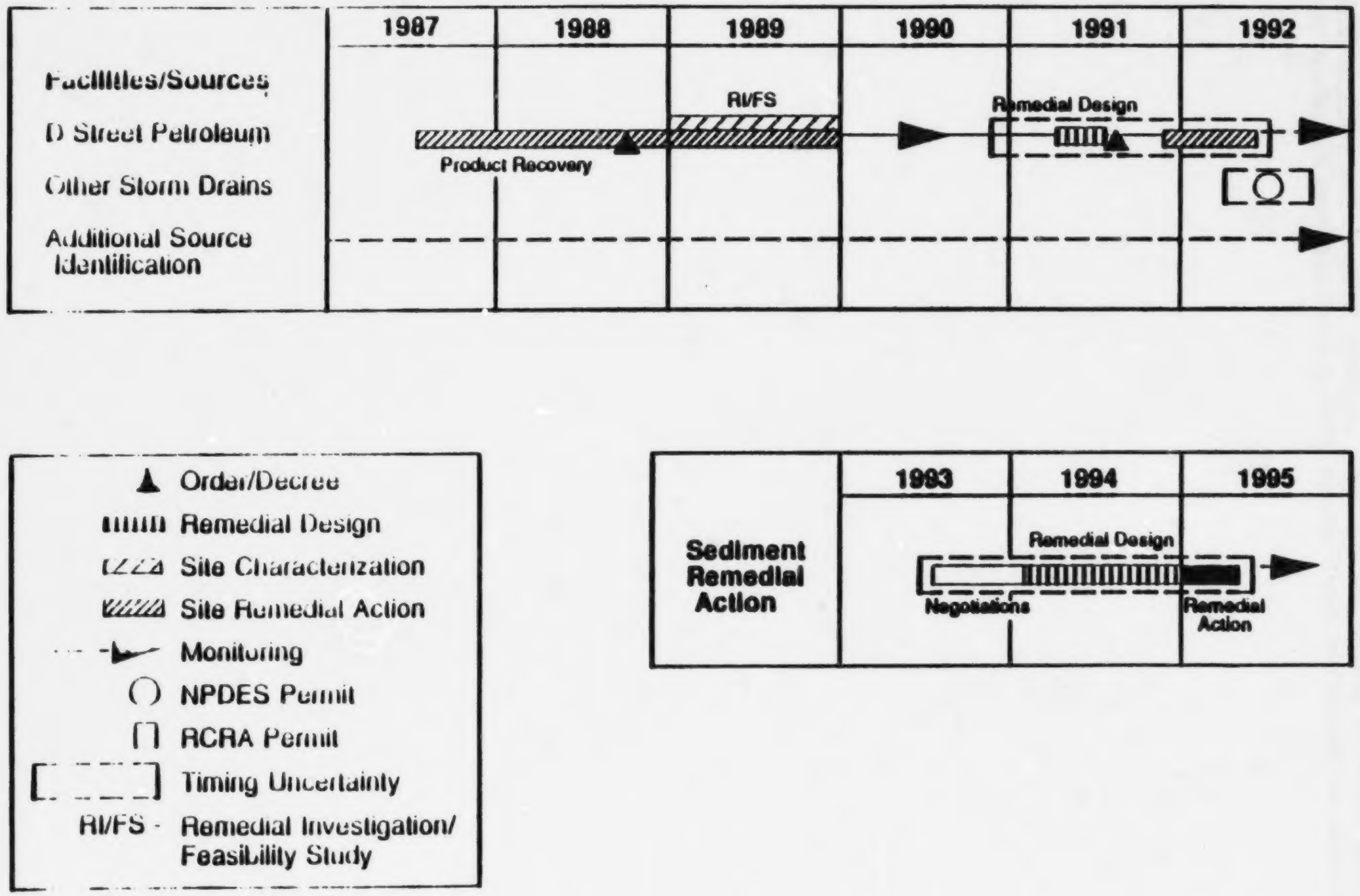


Figure C-13. Recent, ongoing, and planned activities at the Mouth of City Waterway

Under the consent order the feasibility study will be completed by December 1989, and the remedial design will be completed in November 1991 or 4 months after levels of free product removal drop below 20 gallons per day for 1 complete month. The remedial action will be conducted under an amended or a new consent order in compliance with the Model Toxics Control Act.

APPENDIX D

Revised Cost Estimate for Confinement Option

CONTENTS

Page

LIST OF TABLES D-iv

REVISED COST ESTIMATE FOR CONFINEMENT OPTIONS D-1

- CORE SAMPLING FOR REMEDIAL DESIGN D-1
- CHEMICAL ANALYSIS FOR REMEDIAL DESIGN D-1
- DESIGN/PERMITTING D-1
- EQUIPMENT MODIFICATIONS D-1
- SITE ACQUISITION D-1
- SITE PREPARATION D-3
- SITE LINER D-3
- EQUIPMENT MOBILIZATION D-3
- CONTAMINATED SEDIMENT DREDGING D-3
- MARINE TRANSPORTATION OF CONTAMINATED SEDIMENT D-3
- OVERLAND TRANSPORTATION OF CONTAMINATED SEDIMENT D-4
- BARGE UNLOADING TO DISPOSAL SITE D-4
- BARGE UNLOADING TO TRUCKS D-4
- CONFINED AQUATIC DISPOSAL SITE DREDGING D-4
- DISPOSAL COSTS AND FEES D-4
- CAPPING OF UPLAND/NEARSHORE DISPOSAL SITE D-4
- CLEAN SEDIMENT DREDGING FOR CONTAMINATED SITE CAP D-5
- CLEAN SEDIMENT TRANSPORTATION FOR CONTAMINATED SITE CAP D-5
- CONFIRMATION SAMPLING D-5
- CONFIRMATION ANALYSIS D-5
- WELL CONSTRUCTION D-5

Page

MONITORING SAMPLING OF DISPOSAL SITE D-5

MONITORING SAMPLE ANALYSIS D-6

ADMINISTRATION D-6

CONTINGENCY D-6

OTHER FACTORS D-6

REFERENCES D-7

LIST OF TABLES

Page

Table D-1. Cost categories applicable to each type of remedial action D-2

REVISED COST ESTIMATE FOR CONFINEMENT OPTIONS

Revised cost estimates for the Commencement Bay/Nearshore Tideflats problem areas were prepared using principally the feasibility study (Tetra Tech 1988) as a source for unit costs and other factors (e.g., dredged deployment costs, production rates, sample analysis costs). Information presented by reviewers of the feasibility study suggested that some unit costs or other factors were questionable or erroneous. In these cases, these estimates were examined and revised in accordance with information presented by the reviewers or available from other sources. Each of the cost categories shown in Table D-1 is discussed below, including the value used, the rationale for its selection, and any special features of its application.

CORE SAMPLING FOR REMEDIAL DESIGN

A collection cost of $1,500 per core is used; this is the figure cited in the feasibility study (Tetra Tech 1988). The number of cores is presumed to be one per 4,000 cubic yards of sediment; this rate corresponds to the value used in the feasibility study and to PSDDA guidance for areas with the highest contamination ranking (PSDDA 1988).

CHEMICAL ANALYSIS FOR REMEDIAL DESIGN

Sample analysis costs differ with the problem area, according to the costs estimated in the feasibility study. These costs ranged from $800 to $1,500 per sample. Analysis of three samples from each core is presumed, in accordance with the feasibility study.

DESIGN/PERMITTING

The cost assigned to this category is $325,000 (Gershman, Brickner & Bratton 1989). The feasibility study does not include this cost category. *Confined Disposal of Contaminated Sediments. Documentation of Standards Development* (Parametrix 1989) recommends costs from $810,000 (for confined aquatic disposal) to $1,860,000 (for an upland mixed disposal site).

EQUIPMENT MODIFICATIONS

Equipment modifications for Commencement Bay sites consist of alterations to the clamshell bucket to make it watertight. The cost of $20,000 per clamshell, cited in the feasibility study, is used. Only one dredge at each problem area is presumed to be practical, hence the cost of one such modification is included for each problem area.

SITE ACQUISITION

Upland disposal is presumed to take place at one of the sites identified in U.S. Army COE 1985). Land costs in a commercial location are estimated to be $25,000 per acre. The total acreage required is computed as a function of the fill depth at the disposal site and the volume of material to be disposed of (after swelling and compaction).

TABLE D-1. COST CATEGORIES APPLICABLE TO EACH TYPE OF REMEDIAL ACTION

Cost Category	Nearshore	Upland	Capping	Overdredging Confined Aquatic Disposal
Siting and Construction				
Core sampling for remedial design	x	x	x	x
Chemical analysis for remedial design	x	x	x	x
Design/permitting	x	x	x	x
Equipment modifications	x	x		x
Site acquisition	x	x		
Site preparation (dikes, weirs)	x	x		
Site liner	x	x		
Operation				
Equipment mobilization	x	x	x	x
Contaminated sediment dredging	x	x		x
Marine transportation of contaminated sediment	x	x		
Overland transportation of contaminated sediment		x		
Barge unloading to disposal site	x			x
Barge unloading to trucks		x		
Confined aquatic disposal site dredging				x
Disposal costs and fees	x	x		x
Capping of upland/disposal site	x	x		
Clean sediment dredging for contaminated site cap	x	x	x	
Clean sediment transportation for contaminated site cap	x	x	x	
Post Closure				
Confirmation sampling	x	x		
Confirmation analysis	x	x		
Well construction	x	x		
Monitoring sampling of disposal site	x	x	x	x
Monitoring sample analysis	x	x	x	x
Administration	x	x	x	x
Contingency	x	x	x	x

SITE PREPARATION

Site preparation costs were assessed only for the upland disposal alternative. These were estimated by using values from Table 5-4 of U.S. Army COE (1985), and applying an annual inflation rate of 5 percent to adjust the 1984 costs to 1989 dollars. The resulting value is $1.30/cubic yard of site capacity. Cost estimates were based on the assumption that all material from the problem area could be disposed of in the upland site, thus this cost is computed as $1.30/cubic yard of contaminated sediment after swelling and compaction.

SITE LINER

Liner costs also were assessed only for the upland disposal option. The liner is presumed to be 3 feet of clay over the entire area of the disposal site. The unit cost is based on Table 5-6 of U.S. Army COE (1985), and inflated from 1982 to 1989 dollars at a rate of 5 percent per year, yielding a value of $22.92/cubic yard of liner. Total cost is computed as the product of site area, liner depth, and the unit cost.

Use of other liner material, inclusion of a membrane, construction of a drainage system, and other modifications of this simple scenario may substantially affect the costs.

EQUIPMENT MOBILIZATION

The feasibility study lumps equipment mobilization with bonding and insurance, and calculates this as a fixed percentage of other costs. The approach used here is to assign a fixed cost to mobilization. The generic unit cost for a clamshell dredge used here is $150,000 per dredge (Parametrix 1989).

For remedial alternatives that include capping of the dredging site, total mobilization costs were based on the assumption that one dredge would be operating in the problem area and another at the source of clean sediment (e.g., the Puyallup River). The mobilization cost of the Puyallup River dredge was apportioned among the problem areas according to the fraction of total area to be capped in each.

CONTAMINATED SEDIMENT DREDGING

The unit cost of dredging may vary considerably, as described above, and as shown in the references. For this cost analysis a value of $3.00/cubic yard is used. This is based on a brief review of recent bids for dredging in Puget Sound (Sumeri, A., 1989, personal communication), which averaged approximately $2.50/cubic yard; and the costs estimated by Corlett and Kassebaum (1989), which ranged from $2.50/cubic yard to $12.00/cubic yard.

MARINE TRANSPORTATION OF CONTAMINATED SEDIMENT

Transportation of sediment by barge is estimated to cost about $0.30/cubic yard-mile, based on the figure of $0.25/cubic yard-mile cited in U.S. Army COE (1985), and adjusted for inflation. This is comparable to the cost of $0.25/cubic yard-mile cited in PSDDA (1988). Transportation costs were based on the volume of sediment after swelling.

OVERLAND TRANSPORTATION OF CONTAMINATED SEDIMENT

Overland transportation of contaminated sediment is estimated to cost $0.50/cubic yard-mile, based on the marine transportation cost and the suggestion that trucking costs will exceed barging costs by about $0.20/cubic yard-mile (U.S. Army COE 1985). Transportation costs were based on the volume of sediment after swelling.

BARGE UNLOADING TO DISPOSAL SITE

A unit cost of $1.25/cubic yard that was used in the feasibility study is used for this cost analysis. Unloading costs were based on the volume of the sediment after swelling.

BARGE UNLOADING TO TRUCKS

A unit cost of $2.50/cubic yard is used, based on an estimated cost of $500,000 for 200,000 cubic yards of sediment (Parametrix 1989). Note that PSDDA (1988) has used a cost of $1.50/cubic yard.

CONFINED AQUATIC DISPOSAL SITE DREDGING

The cost of confined aquatic disposal site dredging is presumed to be equivalent to that for dredging of contaminated sediment (i.e., $3.00/cubic yard). Because of the overdredging approach, however, the sediment removed to create the confined aquatic disposal site will be deeper than the contaminated material. This additional depth may increase the unit cost. For example, Corlett and Kassebaum (1989) estimate that at the head of City Waterway problem area, removal of the first five feet of sediment will cost $2.50/cubic yard, but removal of the underlying three feet will cost $8.00/cubic yard.

The volume of material to be dredged for the confined aquatic disposal site is computed as the swollen and compacted contaminated volume plus the capping depth times the contaminated area. No estimation was attempted of the excess volume that would have to be dredged due to slumping of the excavation.

DISPOSAL COSTS AND FEES

The fee of $0.40/cubic yard proposed by the Washington Department of Natural Resources (Corlett and Kassebaum 1989) for disposal at PSDDA Phase I disposal sites is used here. It is applied only to the excess volume of clean sediment removed from the confined aquatic disposal site. This sediment is presumed to meet PSDDA guidelines for open-water disposal.

CAPPING OF UPLAND/NEARSHORE DISPOSAL SITE

The unit cost used is based on a cap of 3 feet of sand and 3 feet of topsoil. In-place costs for these materials are taken from Table 5-6 of U.S. Army COE (1985), and inflated from 1982 to 1989 costs at a rate of 5 percent per year. The resulting average unit cost is $23.34/cubic yard of capping material. The total volume of capping material is computed by multiplying the upland site area times the depth of cap (2 yards). A similar approach could be taken to estimating capping costs for a nearshore disposal site.

This generic cap may not be suitable for all sites; some may require a greater depth of material, different material (synthetic fabric, asphalt, concrete, or clay), revegetation, or other special measures taken for drainage or erosion control.

CLEAN SEDIMENT DREDGING FOR CONTAMINATED SITE CAP

Dredging of clean sediment is presumed to have a cost equivalent to that of contaminated sediment dredging ($3.00/cubic yard).

CLEAN SEDIMENT TRANSPORTATION FOR CONTAMINATED SITE CAP

Transportation of clean sediment is presumed to have a cost equivalent to that of marine transportation of contaminated sediment ($0.30/cubic yard-mile.).

CONFIRMATION SAMPLING

Confirmation sampling following removal of dredged material is presumed to be carried out by the collection of a grab sample of the sediment surface rather than a core, following the suggestion of the Commencement Bay Group (ENSR 1989). The cost of sample collection is estimated to be $500 per grab, producing one sample per grab. The number of samples is estimated as in the feasibility study: two samples per acre, with a maximum of 20 samples at a site.

CONFIRMATION ANALYSIS

Samples taken to confirm the success of remedial dredging are presumed to be analyzed for the same contaminants as the samples used to characterize the problem areas. Thus, the analysis cost varies with the problem area as specified in the feasibility study.

WELL CONSTRUCTION

The costs of establishing groundwater monitoring wells at upland and nearshore sites are based on drilling costs of $22.00 per foot, $600 for a screen (Deremer, R., 1989, personal communication), and an estimated $800 for a pump and equipment deployment. These unit costs were applied to an estimated 20 wells (the maximum number of sediment monitoring stations suggested by the feasibility study) of an average depth of 35 feet (the depth of fill possible at Blair Waterway Slip 1).

MONITORING SAMPLING OF DISPOSAL SITE

Sampling of confined aquatic disposal and capping sites is presumed to take place by coring, as specified in the feasibility study, with a cost of $1,500 per core. Frequency of sampling is two cores per acre, with a maximum of 20 cores. Sampling is presumed to be conducted yearly, and three samples analyzed from each core.

Sampling of groundwater monitoring wells is estimated to cost $120 per well, based on two hours of labor at $30 per hour (including sampling by a safety-certified specialist, document control, quality assurance, data management, and reporting), $30 of other direct costs per well, and a multiplier of 1.5. Frequency of sampling is presumed to be equivalent to that for coring at confined aquatic disposal and capping sites.

MONITORING SAMPLE ANALYSIS

Analysis costs for monitoring samples are presumed to be site-specific, as was assumed for the analysis costs for remedial design sampling and confirmation sampling. The site-specific costs used are those listed in the feasibility study.

ADMINISTRATION

Administration costs calculated in the feasibility study were as a percentage of all other costs. A similar approach was taken for the spreadsheet cost analysis. The feasibility study estimate included engineering costs, however, which were included in the design and permitting classification in the revised cost analysis. The factor for administration cost was therefore revised downward from the feasibility study value of 15 percent to 8 percent. The *EPA Remedial Action Costing Procedures Manual* (U.S. EPA 1985) suggests a range of 7-15 percent of capital costs for administration, including design and monitoring. The typical cost suggested by the *Multiuser Confined Disposal Sites Program Study* (Gershman, Brickner, and Bratton 1989) is 6 percent.

CONTINGENCY

A contingency cost of 20 percent of all other costs was applied. This is the same proportion used for the feasibility study.

OTHER FACTORS

Two factors were used to estimate the effect of sediment swelling and compaction. The swelling factor determines the increase in sediment volume after dredging and deposition in a barge; and the compaction factor determines the decrease in volume after confinement and compaction of the sediment. The swelling factor used for the revised cost estimate is 0.75, meaning that sediment would increase in volume by 75 percent upon dredging (Church 1981). As noted previously, this factor may be highly variable, so a value at the upper range of reported swelling factors was chosen. The compaction factor was chosen so that the net volume change from the original sediment in place would be an increase of 20 percent; the value of this factor is therefore selected to be 0.69 (i.e., 1.20/1.75).

The discount rate used for this revised cost calculation is 7 percent, which is a slightly lower estimated rate than the current rate of return on 2-year Certificates of Deposit.

The production rate for dredging was presumed to be 200 cubic yards/hour, as shown in Table 5-2 of U.S. Army COE (1985) for a 5-cubic yard clamshell dredge.

A dredging lift depth of four feet, typical of clamshell dredges (PSDDA 1988) is used for this calculation. The actual volume dredged is calculated based on the number of dredging lifts that would completely remove the contaminated sediment. Thus, contamination to a depth of 2 feet would require one dredging lift (with overdredging of 100 percent), whereas contamination to a depth of 5 feet would require two dredging lifts (with overdredging of 60 percent).

REFERENCES

Church, H.K. 1981. Excavation handbook. McGraw-Hill, New York, NY. 750 pp.

Corlett, R.F., and C. Kassebaum. 1989. Comments on sediment remediation alternatives. Prepared for the Commencement Bay Group. ENSR Consulting and Engineering. 52 pp.

Deremer, R. 1989. Personal Communication (private well drilling cost quote prepared for Mr. Dreas Nielsen, PTI Environmental Services, Bellevue, WA). Northwest Pump, Inc.

ENSR. 1989. Technical review and comments, Commencement Bay Nearshore/Tideflats remedial investigation and feasibility study. Prepared for the Commencement Bay Group. ENSR Consulting and Engineering.

Gershman, Brickner & Bratton. 1989. Multiuser confined disposal sites program study, cost analysis issue paper. Prepared for PTI Environmental Services, Bellevue, WA and Washington Department of Ecology, Olympia, WA. Gershman, Brickner & Bratton, Inc.

Parametrix. 1989. Confined disposal of contaminated sediments documentation of standards development. Draft Report. Prepared for Washington Department of Ecology. Parametrix, Inc., Bellevue, WA.

PSDDA. 1988. Evaluation procedures technical appendix - Phase I (central Puget Sound). Public Review Draft. Prepared by the Evaluation Procedures Work Group for Puget Sound Dredged Disposal Analysis. U.S. Army Corps of Engineers, Seattle, WA.

Sumeri, A. 1989. Personal Communication (telephone conversation with Mr. Dreas Nielsen, PTI Environmental Services, Bellevue, WA; discussion of recent bids for dredging in Puget Sound). U.S. Army Corps of Engineers, Seattle District, Seattle, WA.

Tetra Tech. 1988. Commencement Bay nearshore/tideflats feasibility study. Public Review Draft. Prepared for the Washington Department of Ecology. Tetra Tech, Inc. Bellevue, WA.

U.S. Army COE. 1985. Evaluation of alternative dredging methods and equipment, disposal methods and sites, and site control and treatment practices for contaminated sediments. U.S. Army Corps of Engineers. Seattle District. Seattle, WA.

U.S. EPA. 1985. Remedial action costing procedures manual. OSWER Directive 9355.0-10. U.S. Environmental Protection Agency, Office of Research and Development. Hazardous Waste Engineering Research Laboratory. 59 pp.